AD-A129 836 RECONNAISSANCE REPORT FOR HYDROPOWER LOCK AND DAM NUMBER 2 MISSISSIPPI RIVER(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 81 1/2

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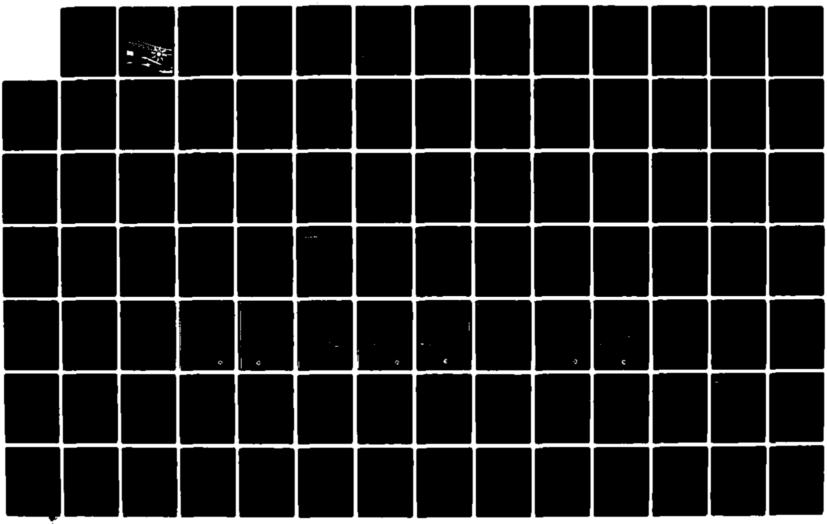

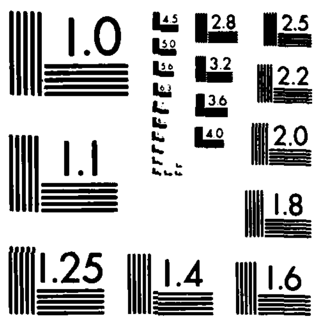

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Reconnaissance Report

HYDROPOWER

Lock & Dam 2

Mississippi River

PRELIMINARY
SUBJECT TO REVISION

UNITED STATES ARMY
CORPS OF ENGINEERS
ST. PAUL DISTRICT
1135 U. S. P. O. & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

SEPTEMBER 1981

UNCLASSIFIED

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This report presents a preliminary investigation of the addition of hydropower at the existing navigation lock and dam #2. The installation of a hydroplant with a 4,000 kilowatt or 5,000-kW nameplate rating is economical. A 5,000-kW would produce an average energy equivalent of 52,000 barrels of oil or 14,000 tons of coal per year.

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RECONNAISSANCE REPORT
FOR HYDROPOWER

LOCK AND DAM 2

MISSISSIPPI RIVER

HASTINGS, MINNESOTA

PERTINENT DATA

LOCK AND DAM 2 - HASTINGS, MINNESOTA

Normal upper pool (feet)	Elevation 687.2
Normal minimum tail water (feet)	Elevation 675.0
Nominal lift (feet)	12.2
USGS gage number	05-3310
Location	St. Paul, Minnesota
Gage drainage area (square miles)	36,800
Project drainage area (square miles)	36,990
Project pool area (acres)	11,810
Maximum flood flow (April 1965) (cfs)	171,000
Average flow (cfs)	10,600
Median of yearly mean discharges (cfs)	9,635
Minimum flow (August 1934) (cfs)	632
Concrete spillway, crest length (feet)	100
Spillway crest at (feet)	Elevation 686.0
Tainter gates (feet)	20 at 30 x 20
Top of tainter gate sill (feet)	Elevation 669.15
Top of earth dike (feet)	Elevation 695.8
Top of lock wall	Elevation 694.0
Flood crest, pool (April 1965) (feet)	Elevation 697.07
Flood crest, tail water (April 1965) (feet)	Elevation 696.05

FEASIBLE ALTERNATIVES

	4-units	5-units
Total nameplate capacity (kW)	4,000	5,000
Plant factor	0.77	0.71
Average annual energy (MWh)	27,100	31,000
Construction first cost	9,870,000	12,010,000
Benefit-cost ratio	1.24	1.18

UNIT DESIGN PARAMETERS

Turbine type	Horizontal propeller turbine with adjustable blades
Runner diameter	118.1 inches (3.0 meters)
Design head	10.5 feet (3.2 meters)
Minimum head	3.3 feet (1.0 meter)
Design flow (cfs/unit)	1,327
Generator nameplate capacity (kW)	1,000
Generator output at design flow (kW/unit)	1,017
Turbine efficiency	.898
Speed increaser efficiency	.98
Generator efficiency	.98

RECONNAISSANCE REPORT

FOR

HYDROPOWER

LOCK AND DAM 2

MISSISSIPPI RIVER

HASTINGS, MINNESOTA

SYLLABUS

This report presents a preliminary evaluation of the addition of hydropower at the existing navigation lock and dam 2. The study shows that installation of a hydroplant with a 4,000-kW (kilowatt) or 5,000-kW nameplate rating is economical. Pertinent data concerning the site and two optional installations are shown on the previous pages.

Severe environmental impacts do not appear to be associated with construction of a plant of the sizes investigated. Hydropower is one of the most ecologically sound means of producing electricity because it uses a nonpolluting, renewable energy source - water flow - allowing nonrenewable energy sources to be conserved.

The energy available at lock and dam 2 can be an important contribution to our Nation's energy independence. A 5,000-kW system would produce an average energy equivalent of 52,000 barrels of oil or 14,000 tons of coal per year.

The District Engineer recommends that the Corps of Engineers prepare a feasibility report which can serve as a basis for congressional authorization for hydropower plant construction at lock and dam 2.

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STUDY AND REPORT

SCOPE OF THE STUDY

The studies presented in this report represent preliminary or reconnaissance level detail. The purpose of the report is to determine whether a feasibility study should be conducted. Significant time and resources can be invested in a feasibility study. Thus, a decision to proceed with a study should be based on a finding that a potentially viable project can be developed. The reconnaissance study is designed to reduce the chance of a subsequent unfavorable finding and maximize the potential for identifying and moving forward with attractive projects. Therefore, the reconnaissance study is a relatively complete small-scale feasibility investigation in which the issues expected to be important in the feasibility stage are raised, and a first cut economic analysis is performed. A favorable economic feasibility finding is a strong indication that further detailed study (a feasibility study) is warranted subject to assessment of potentially critical negative issues.

STUDY AND AUTHORITY

The reconnaissance study for hydropower at lock and dam 2 was under the authority contained in the House Committee on Public Works resolution, dated 11 December 1969, which requests the Corps of Engineers:

> ". . . to review the reports of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River. . . with a view toward determining whether any modifications of the existing project should be made at this time in the interest of providing increased flood control, and for allied purposes on the Mississippi River."

COORDINATION AND STUDY PARTICIPANTS

Because this reconnaissance study is preliminary, an intensive public involvement program was not conducted. Agencies and interests were informed of the initiation of the study and were invited to participate in the study. A copy of the notice and pertinent responses are included in Appendix B, Coordination.

Primary participants in the study include the Federal Energy Regulatory Commission (FERC), Fish and Wildlife Service (FWS), and the St. Paul District, Corps of Engineers. Under the Federal Power Act and other legislation, FERC has broad responsibilities related to planning, construction, and operation of water resource projects, particularly in regard to power development. One of these responsibilities is establishment of values for power that might be produced at lock and dam 2. Correspondence related to power value determination is included in appendix B.

The FWS, under the authority of and in accordance with the Fish and Wildlife Coordination Act, is the primary agency from which the Corps of Engineers will obtain Federal fish and wildlife resource data and planning input. The FWS has provided preliminary comments regarding a potential hydropower project at lock and dam 2. Its planning aid letter is included in appendix B.

The Department of Energy (DOE), Office of Power Marketing Coordination, is responsible for all marketing of Corps-produced power. This office has not been officially contacted regarding distribution of any power that may be produced at lock and dam 2. If a feasibility study is done, coordination will be maintained regarding power marketing.

The St. Paul District, Corps of Engineers, is chiefly responsible for this study and the report. The reconnaissance report will serve as a coordination vehicle because it will be distributed to all interested Federal and State agencies and the public. Comments received will help guide future efforts during the feasibility study.

STUDY BY OTHERS

No other agency or interest has studied lock and dam 2 in detail for hydropower addition. The Corps of Engineers is completing the National Hydropower Study; lock and dam 2 is one of the sites investigated.

The National Hydropower Study was authorized by Section 167 of the Water Resources Development Act of 1976 (Public Law 94-587). The study is to provide a general but comprehensive appraisal of the potential for incremental or new hydropower generation at existing dams and other water resource projects as well as undeveloped sites in the United States. Preliminary results of that study, which is being managed by the Institute for Water Resources of the Corps of Engineers, show apparent economic feasibility for hydropower addition at lock and dam 2.

In addition to the Corps' study of hydropower at lock and dam 2, on 3 November 1981, Mitchell Energy Company, Inc., of Boston, Massachusetts, filed an application for a FERC preliminary permit to study hydropower at lock and dam 2. Competing applications for the same preliminary permit at lock and dam 2 have been submitted by the following concerns:

1. Shive-Hattery and Associates of Cedar Rapids, Iowa, submitted on 24 February 1981, on behalf of the city of Shakopee, Minnesota.
2. Enagenics of Washington, D.C., submitted on 3 March 1981.
3. Public Utilities Commission, City of Hibbing, Minnesota,(1) submitted on 3 March 1981.
4. Northwestern Minnesota Municipal Power Agency, submitted on 15 May 1981.
5. City of Winona, Minnesota, submitted on 12 March 1981.

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(1) The city of Hibbing in late September 1981 filed an application for license for hydropower development at lock and dam 2.

Funding for hydropower feasibility studies is likely to be granted to at least one of the aforementioned FERC permit applicants as allowed under the Public Utilities Regulatory Policies Act of 1978 (PURPA). Under the PURPA program, low interest loans are granted to defray 90 percent of a hydropower feasibility study. If the alternatives proposed in the study are found to be infeasible, the loan may be forgiven. This program provides strong incentive to both the private sector and local interests to study hydropower feasibility at existing dams. In the case of lock and dam 2, this incentive may very well lead to a duplication of study efforts between the Corps and one or several FERC permit applicants.

Regarding this duplication issue, the Corps of Engineers is committed to sound hydropower development in the overall interest of the public, regardless of which entity (Corps or non-Federal) actually develops the hydropower. In the case of non-Federal development at lock and dam 2, close coordination between the Corps and the non-Federal concern will be maintained. The Corps would review proposed hydropower development by other interests to assure that the navigational requirements and operations of lock and dam 2 are properly addressed. While this coordination and review effort favors Corps hydropower development, the realization that the private sector has the ability to put hydroplants on line years before the Corps is also a consideration. As noted, there are good reasons for study efforts by the Corps, and there are good reasons for non-Federal interests to study the hydropower capabilities at lock and dam 2. A duplication of study efforts between these entities would not be in the overall interest of the public. Therefore, this duplication issue should be addressed during further hydropower study at lock and dam 2.

THE REPORT AND STUDY PROCESS

Results of the reconnaissance studies are contained in this report including recommendations for further feasibility investigations. The report consists of a main report (including plates showing drawings of selected alternatives) and technical appendixes.

The reconnaissance study was started in January 1981 and culminates with this report. If warranted and approved by Corps of Engineers higher echelons, the feasibility study for hydropower addition at lock and dam 2 will begin in October 1981 and will be completed in fall 1983. The final feasibility report would be submitted to Congress which could authorize a hydropower project at lock and dam 2. However, the authorization, advance planning, and funding by Congress are necessary before any recommended actions could be taken.

PROBLEM IDENTIFICATION

NATIONAL OBJECTIVES

In accordance with the Principles and Standards for Planning Water and Related Land Resources, national economic development and environmental quality are the two principal planning objectives. These guidelines mandate that all federally assisted water resources projects be planned to achieve these national objectives:

- National Economic Development (NED) - Enhance the development of the Nation's economy by increasing the value of the output of goods and services and improving national economic efficiency.

- Environmental Quality (EQ) - Enhance the quality of the environment by managing, conserving, preserving, restoring, or improving natural and cultural resources and ecological systems.

The social well-being and regional development accounts are also considered important. Viable alternatives to solve current and prospective water and related land resource problems will be evaluated and examined in light of the goals of increasing national and regional economic gains, enhancing the quality of the environment, and improving social well-being.

EXISTING CONDITIONS

Lock and dam 2 is located on the Mississippi River at river mile 815.2 in Hastings, Minnesota. It is one of the 13 navigation locks and dams built in the 1930's along the Upper Mississippi River in the St. Paul District. The existing main lock is 600 feet in length by 110 feet in width and provides a 12-foot lift. The riverward lock, no longer in use, is 500 feet in length and 110 feet in width. The dam is 822 feet long. It contains 20 tainter gates in a 600-foot section and includes a fixed crest concrete spillway dam 100 feet in width. The navigation pool formed by lock and dam 2 is 32.5 miles in length and includes metropolitan St. Paul. The contributing drainage area to lock and dam 2 is approximately 36,990 square miles.

A small 40-kW turbine generator was installed in the riverward lock as part of the original construction of lock and dam 2 but is not in use at the present time. The rehabilitation and future power production of this generator are examined in appendix F.

The potential market area for newly developed hydropower at lock and dam 2 includes several municipalities that would be designated as preferred customers for the sale of federally generated power. As preferred customers, these municipalities would probably receive priority consideration in the sale of energy generated at lock and dam 2. Northern States Power Company serves the potential market area and is another potential customer.

STRUCTURAL INTEGRITY

The stability and structural integrity of lock and dam 2 are considered to be good with the possible exception of the riverward lock. At the present time the riverward lock is not operational. The foundation condition that caused the shutdown of the lock was first noticed in the mid-1930's when rotation of the land walls caused problems with the lower miter gate. This rotation was monitored from 1938 through 1946. During this time the lower miter gate became increasingly hard to close and maintain a seal. The lock was kept in

operation until the landward lock was completed in 1948. Due to this foundation condition, installation of hydropower turbines in the riverward lock would necessitate detailed investigation to determine the stability of the landward wall.

The latest periodic inspection in 1971 indicated that no appreciable settlement or change of alignment had occurred at the landward lock, spillway dam, and regulating dam. These sections of lock and dam 2 seem to be structurally suitable for the installation of hydropower turbines.

Long-term erosion poses no threat to the stability of lock and dam 2. The scour pattern has shown no significant change for more than the past 5 years. With any hydropower addition, precaution would be taken in order to prevent scour.

HYDROLOGIC POWER EVALUATION

The flow available for energy production at lock and dam 2 is estimated from 80 years of record at the USGS gage at St. Paul, Minnesota (USGS 05-3310). This gage is 24.1 river miles upstream from the project site at Hastings. The total drainage area at the project is 36,990 square miles, which is 0.5 percent greater than the area upstream of St. Paul. There are no major tributaries between the gage and the site; however, 250-350 cfs (cubic feet per second) is discharged into the river downstream of the gage by the Metropolitan Wastewater Treatment Plant. The gaged flows were not adjusted either for drainage area or for the diversion flow. For purposes of this report, the diversion flow was assumed to be equal to losses for lockages and aeration.

Power production would cease when head drops below approximately 3 feet, which corresponds to flows above 38,000 cfs. Flows at the site would exceed this value about 15 days per year on the average (i.e., about 4 percent of the time). Normally these higher flows occur because of spring snowmelt or heavy rains. The period of spring snowmelt flooding

is highly variable. For instance, during the 1965 flood of record, the gates were out of the water for about 21 days, and hydropower production would have ceased for about 75 days. In contrast, the 1981 spring snowmelt peak was 8,100 cfs on 28 February, and hydropower production would have been continuous during that event.

The average monthly flows at St. Paul are shown in table 1 below.

Table 1 - Average monthly flows, Mississippi River at St. Paul, Minnesota

Month	Flow (cfs)	Month	Flow (cfs)
January	4,000	July	12,700
February	4,000	August	8,000
March	9,700	September	7,400
April	23,800	October	7,600
May	19,000	November	6,900
June	16,800	December	4,800

The production of power from the force of falling water follows from basic principles of physics. Work (energy) can be expressed as a force moving through a distance:

Work = Force x Distance (lb-ft)

In the case of hydropower production, the force is the weight of the water, and the distance is the vertical fall, or "head," which is the difference between pool and tail-water elevations.

$$E = F \times D = (\text{unit weight of water}) \times (\text{volume of water}) \times (\text{net head})$$

$$E = \gamma w \cdot (V) \cdot (H) = 62.4 \cdot (V) \cdot H \text{ (lb-ft)} \quad (1)$$

Power is the rate at which the energy is produced. If the head is presumed constant over a short interval, then the power available is:

$$P_a = \frac{dE}{dT} = 62.4 \times \frac{dV}{dT} \times H = 62.4 \cdot Q \cdot H \qquad \frac{\text{lb-ft}}{\text{Sec}} \qquad (2)$$

where Q represents the flow in cfs.

Expressed as horsepower: (1HP = 550 lb-ft/sec)

$$P_a = \frac{62.4}{550} \times Q \times H = \frac{(Q)(H)}{8.81} \qquad \text{(HP)} \qquad (3)$$

or as kilowatts: (1HP = .746 kW)

$$P_a = \frac{Q \times H}{8.81} \times .746 = \frac{(Q)(H)}{11.82} \qquad \text{(kW)} \qquad (4)$$

To take into account the efficiency of the machine, a factor "e" is added to the equation for each "transfer point" in the process:

e_t = turbine efficiency

e_m = speed increaser efficiency

e_g = generator efficiency

$$e = e_t \times e_m \times e_g$$

and the net power is:

$$P_{net} = \frac{Q \cdot W \cdot e}{11.82} \qquad (5)$$

For preliminary calculations involving modern machinery, an average overall efficiency of about 0.86 is often used. Then:

$$P = \frac{(Q)(H)(0.86)}{11.82} = \frac{(Q)(H)}{13.7} \qquad \text{(kW)} \qquad (6)$$

Power is the rate of production of energy, so the total energy produced in a given period is found by multiplying the average power during the period, in kilowatts, by the length of the period, in hours.

$$E = \text{Power (kW)} \times \text{time (hours)} = \text{kilowatt-hours (kWh)} \qquad (7)$$

Sometimes energy is expressed in megawatt-hours (MWh) or in gigawatt-hours (GWh):

$$1 \text{ MWh} = 1{,}000 \text{ kWh}$$
$$1 \text{ GWh} = 1{,}000 \text{ MWh}$$

Since the flows at a given site are usually quite variable, it would be useful to store excess volumes for use during lower flow periods. Usually low-head dams such as the St. Paul District's navigation dams have only minimum storage available (pondage). For several reasons, including navigation, wildlife environment, recreation, and business interests, pool fluctuations are kept to a minimum; and without pool fluctuations, the useful storage is negligible. An allowable fluctuation range of 0.4 foot would give about 4,700 acre-feet of storage, which would give about 10 hours of operation for a 5-megawatt plant. This may give some flexibility in operation of the plant, but it will not allow storage of high flows for later use. This type of plant, with low available storage capacity (pondage) is called a "run-of-river" plant.

For run-of-river plants, an analysis using the flow-duration technique is satisfactory for determining available power and energy. Usually, the flow is represented by the flow-duration curve, and an average head is used. However, for this and similar cases where head is variable, it is appropriate to consider this variation. This method is shown in Appendix C, Hydrologic Power and Energy Analysis. Included in this analysis are sections for average annual energy, firm power analysis, and average weekly generation.

ENVIRONMENTAL SETTING

Terrestrial Resources

The main geographic feature of the study area is the Mississippi River valley. The St. Croix River enters the Mississippi River at Prescott, Wisconsin, approximately 4 miles downstream of lock and dam 2.

The vegetation in the study area is primarily hardwood forest. Pools 2 and 3 contain a variety of vegetation types with extensive areas of marsh and aquatic vegetation.

The floodplain of pools 2 and 3 provides a habitat for abundant wildlife. Terrestrial game species and migratory birds are common.

Aquatic Resources

Pools 2 and 3 of the Mississippi River contain a number of aquatic habitats in addition to the main river channel. Backwater areas of shallow depth and silt bottoms are common to the pools. These two major habitat areas, together with others found in pools 2 and 3, provide a habitat for 51 species of fish (25 are common or abundant).

Water quality at lock and dam 2 is relatively good but is decreased by the discharge at the Metropolitan Wastewater Treatment Plant which adds more than one-half of the biochemical oxygen demand and nutrient loading. To add dissolved oxygen at lock and dam 2, water is passed over a bulkhead during low flows.

Social Setting

Lock and dam 2 is within the northern corporate boundary of Hastings, Minnesota. The population of Hastings was 15,457 in 1975.

Recreational Resources

Pool 2 is not heavily used for recreational purposes due to commercial traffic on the river and poor water quality. Sightseeing is the predominant recreational activity.

Pool 3 better serves the recreationist. Hunting is a popular recreational activity. The St. Croix River enters pool 3 and is used by many recreational boaters locking through lock and dam 2. Boaters also use several private marinas and harbors located along pool 3.

Cultural Resources

No known prehistoric and/or historic sites are recorded within the immediate project area. As of 1 March 1981, no sites currently listed on or eligible for the National Register of Historic Places are in the immediate project area.

A more thorough discussion of the environmental setting of the project is presented in appendix E.

CONDITIONS IF NO ADDITIONAL FEDERAL ACTION IS TAKEN

If no Federal hydropower is recommended and subsequently developed, one of two futures is probable. One future is no action or no change from existing conditions. This case would have no environmental or social impacts other than those expected under present conditions. However, with no action, several opportunities will be foregone including utilization of a renewable and environmentally clean energy source and capitalization on a relatively economical source of energy.

A more probable alternative future is the development of lock and dam 2 for hydropower by someone other than the Federal Government. As mentioned previously, low-cost federally financed loans for feasibility studies and

licensing are available for investigation of proposed projects associated with existing dams not being used to generate hydropower. Even though lock and dam 2 is federally owned, non-Federal entities are not prohibited from applying for hydropower licensing at such a Federal site. In addition, Federal low interest loans for construction are available to small rural communities and certain nonprofit organizations for such developments. Thus, if the Federal Government does not add hydropower to lock and dam 2, some other interest will probably add it because incentives appear present.

Impacts of non-Federal development would probably not differ appreciably from those that would occur with Federal development. Opportunities foregone in the no action alternative would be regained with this alternative.

PLANNING CONSTRAINTS

Any possible hydropower development plan proposed for lock and dam 2 must be technically and economically sound, socially and environmentally acceptable, and capable of being implemented. Technical factors include constraints that:

1. The plan fit in with the geometric configuration of the existing structures and not adversely affect navigation, which is the principal and primary purpose for lock and dam 2.

2. The plant must operate as a run-of-river facility chiefly to eliminate adverse environmental effects.

To be recommended for further study, the selected plan must be economically justified. In other words, the benefits of the installation must outweigh the costs for construction and maintenance.

Possible adverse impacts on wild and scenic rivers, historic sites, endangered species, migratory fish, wildlife, and other environmental amenities must be assessed. Significant impacts should be eliminated if possible and mitigated when they cannot be eliminated.

Finally, the authority for this study limits the area of consideration solely to that of the original and existing project. Any other options not directly associated with lock and dam 2 would have to be addressed under other authorities.

PLANNING OBJECTIVES

The objectives of the study are derived from problems identified for the area and from Federal, State, and local laws and regulations. In addition, the "Principles and Standards for Planning Water and Related Land Resources" require that all federally assisted water resource projects be planned to achieve the national objectives stated earlier.

Specific planning objectives are definite needs, opportunities, and problems that can be addressed to enhance national economic development or environmental quality. Specific planning objectives for this study include:

1. Increase the national economic efficiency through the development and full utilization of a renewable and less costly energy source, thus helping to reduce dependence on foreign fuels in the Nation and study area during the period of analysis.

2. Contribute to a maximum reduction in the use of nonrenewable fossil fuels in the study area and the Nation during the period of analysis, resulting in conservation of those resources and in the enhancement of the environment by reducing air pollution associated with plant emissions and terrestrial degradation associated with fossil fuel discovery and mining.

3. Minimize site-specific environmental effects of hydropower development.

FORMULATION OF PRELIMINARY ALTERNATIVES

PLAN FORMULATION RATIONALE

The purpose of the formulation of preliminary plans is to identify and evaluate alternative measures for fulfilling the national and specific planning objectives. Plan formulation is iterative and designed to identify and evaluate all possible solutions so that the best and most feasible solution can be selected. For this reconnaissance report, formulation is not based on detailed technical evaluation of all preliminary alternatives, but is based to a large degree on professional judgment. The level of detail for this report is only designed to answer whether a feasible soluion can probably be developed and whether the study should be continued. If warranted, feasibility studies will commence, and alternatives will be more thoroughly evaluated.

An interdisciplinary team was assembled early in the reconnaissance study to develop a strategy for selecting a site along the dam and adjoining dike at which installation of hydropower might be most practical from all viewpoints of the team. After the site was selected, the team met periodically to evaluate the different scales of development and use of different machinery to find the most cost effective and least environmentally damaging measures.

ALTERNATIVES CONSIDERED

As mentioned previously, lock and dam 2 consists of a landward lock, riverward lock, spillway dam, movable dam with 20 adjustable tainter gates, and earth dike. The alternatives that will be presented in this report located turbine/generators in the spillway dam, riverward lock (not operational), and between the two locks. The earth dike was excluded as a possible site for turbine location because of the extensive evcavation that would be required. Furthermore, on the southeast end of the dike, the sensitive and fragile environmental system of Lake Rebecca would suffer an adverse impact if river flow to drive the turbines were diverted

through the lake. Also excluded as possible turbine sites were the landward lock and movable dam due to their navigational and regulating functions.

The preliminary data for lock and dam 2 were submitted to Allis-Chalmers Corporation for estimates of available energy and proposed plant size. Their reply is shown in appendix B. The three proposals from Allis-Chalmers are:

Number of units	Size	Vane angle	Average annual energy
8	3.0 meters	B	44,100 MWh
9	3.0 meters	B	46,200 MWh
10	3.0 meters	A	45,300 MWh

The above figures for average annual energy are slightly greater than those determined during subsequent investigation.

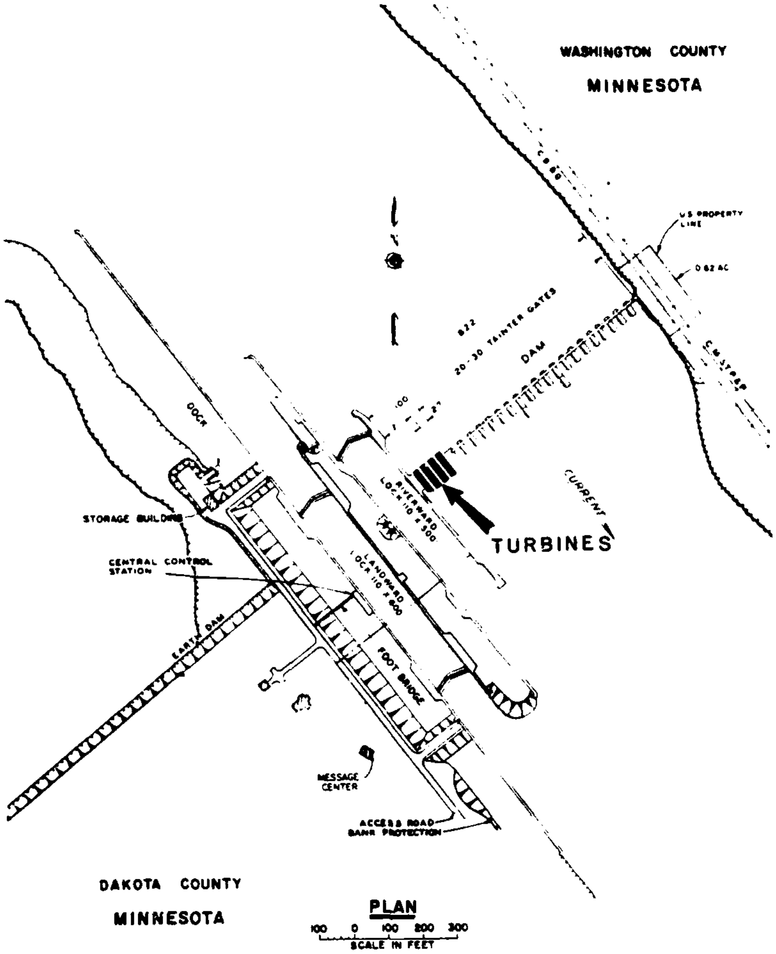
In order to evaluate a wider range of alternatives, the interdisciplinary team decided to examine five optional scales of development. Because Allis-Chalmers tube turbine units are standardized and appeared to be most economical for low-head applications, the five optional scales of development were based on using those units. Each site mentioned for turbine installation can accommodate four or five of these units.

A 3.00-meter (9.84-foot) runner diameter unit was selected, primarily because of head and flow characteristics and input from Allis Chalmers. The five optional scales of development, 4, 5, 8, 10, and 12 units, are rated at a head of 3.2 meters (10.5 feet) and would produce 4, 5, 8, 10, and 12 MW, respectively. The alternatives considered are listed below and illustrated in figures 1, 2, and 3.

Alternative 1 - 4-MW option - Four units located in the spillway dam.
Alternative 2 - 5-MW option - Five units located in the spillway dam.
Alternative 3 - 8-MW option - Four units located in both the spillway dam and riverward lock.
Alternative 4 - 10-MW option - Five units located in both the spillway dam and riverward lock.
Alternative 5 - 12-MW option - Four units located in the spillway dam, four units in the riverward lock, and four units between the locks.

ALTERNATIVE 1

4 TURBINES IN SPILLWAY DAM



ALTERNATIVE 2

5 TURBINES IN SPILLWAY DAM

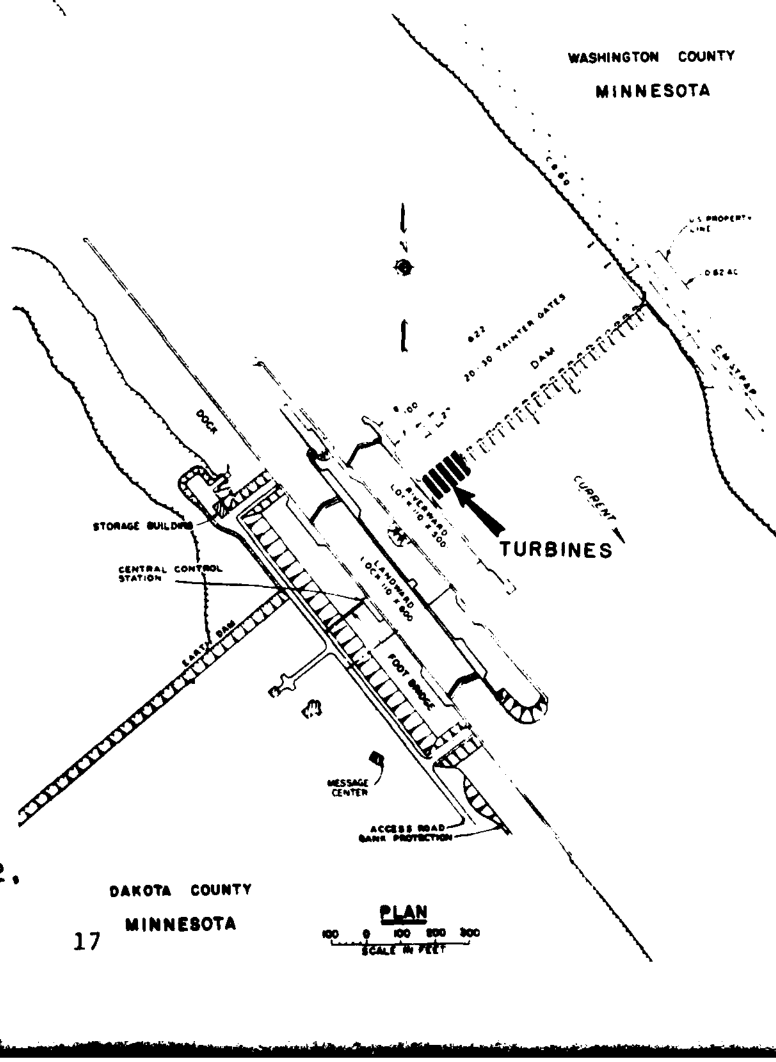


FIGURE 1. ALTERNATIVES 1 & 2, PLAN VIEW

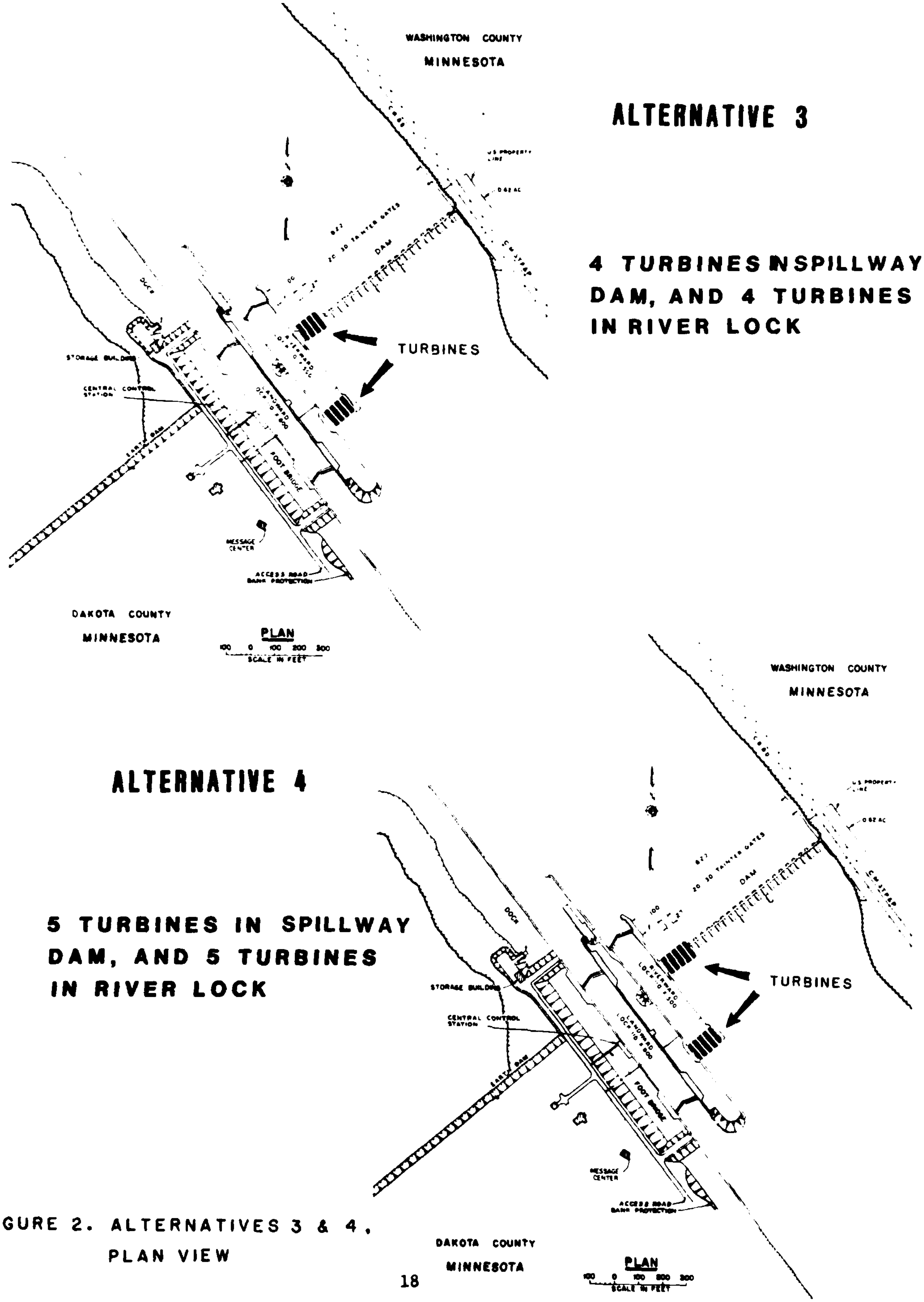
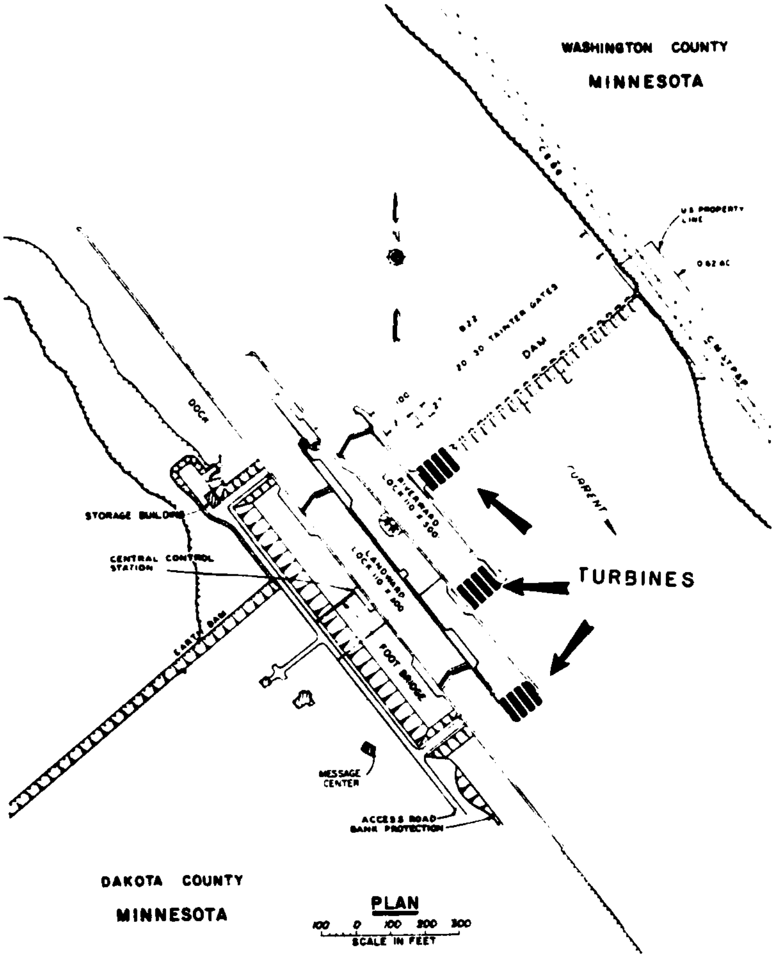


FIGURE 2. ALTERNATIVES 3 & 4, PLAN VIEW



ALTERNATIVE 5

4 TURBINES IN SPILLWAY DAM, 4 TURBINES IN RIVER LOCK, AND 4 TURBINES BETWEEN LOCKS

FIGURE 3. ALTERNATIVE 5, PLAN VIEW

The following sections assess and evaluate these alternatives from their economic and environmental perspectives as well as their physical and engineering feasibility. Financial feasibility analysis to determine specific cash flow characteristics of the project was not undertaken for this stage of study.

ECONOMIC ANALYSIS

Economic feasibility analysis compares economic costs with project benefits. The comparison is made using a common value base. Costs and benefits are stated in dollar values as of October 1980, and this fixed price level is used for valuing future costs and benefits. The time frame used for the benefit-cost analysis begins in 1990 when the project is assumed to be installed and extends through the 100-year economic life of the project (to 2090). Therefore, the benefit-cost comparison was prepared for the year 1990 using current dollars and prices.

The Chicago Regional Office of the Federal Energy Regulatory Commission (FERC) did the benefit analysis of a hydropower addition to lock and dam 2. In its 13 April 1981 letter to the St. Paul District, FERC calculated the benefits as follows:

> "Using a coal-fueled steam-electric plant as the most likely alternative to the proposed hydroelectric project, power values are summarized in the attached table. These are "at market" values; no transmission line costs for the hydroelectric development have been included. All values are based on October 1, 1980 levels and reflect the following general assumptions:
>
> <u>Basis for Measuring Power Value</u>
>
> Power values are the benefits produced by a hydroelectric plant and reflect a measure of society's 'willingness to pay' for the power produced. Because willingness to pay cannot be directly measured, power values are based on the surrogate costs of constructing and operating the most likely alternative if the hydroelectric project is not constructed. This cost is given as the investment cost (capacity value) necessary to construct the most likely alternative and the production cost (energy value) which results from operation of the alternative.

"Power values are based on an analysis of the difference in 'system' costs resulting from the system being operated using the alternative and using the proposed hydropower addition. System operating costs for each of these cases are simulated using a probabilistic production costing computer model. The POWRSYM Version 48 production costing model was used for this analysis.

Electric 'System' Simulated Using the Model

The Northern States System, as projected to exist in 1990, was selected as the 'system' simulated using the production costing model. For 1990, the total energy requirement for this utility is projected to be 34,300,000 megawatt-hours with a peak load of 7,710 megawatts expected to occur during the summer period.

Adjustment Factors Applied to Power Values

The capacity values include a credit of 5 percent to reflect the greater operating flexibility of the hydroelectric plant. In addition, the capacity values for the several proposals have been adjusted by -8, -21, and -28 percent, respectively, to incorporate the relative value of the hydroelectric plant capacity based on its availability in comparison with the availability of the alternative coal-fueled steam-electric plant. Accordingly, the capacity values given in the attached table are applicable to the installed capacity of the proposed hydroelectric plants and already incorporate the consideration of dependable capacity.

The energy values given in the attached table reflect the inclusion of the 'energy value adjustment' which results from the difference in annual 'system' energy production between the steam-electric alternative and the hydroelectric project. Energy values are given based on both current fuel cost levels and on projected real fuel cost increases. Real fuel cost escalation factors were taken from Department of Energy data published October 27, 1980 in the Federal Register, Part XII. Real fuel costs were increased at the rate of 9.55 percent per year for the period 1981-1985, 1.66 percent for 1986-1990, and 0.61 percent for 1991-2010. Costs beyond 2010 were assumed to remain constant at the year 2010 level. Escalated costs assume a 1990 project-on-line date. Costs were levelized over the 100 year life of the hydroelectric plant using 7 3/8, 8 1/2, 10, and 12 percent costs of money."

FERC's letter is included in its entirety in appendix B. The following power value summary of table 2 reflects the information conveyed in FERC's letter. It should be noted that FERC evaluated only the 5-, 8-, and 10-MW alternatives. The 4- and 12-MW alternatives were added after the FERC evaluation. To obtain a capacity benefit value for these alternatives, a set of capacity versus capacity benefit curves was plotted using the information

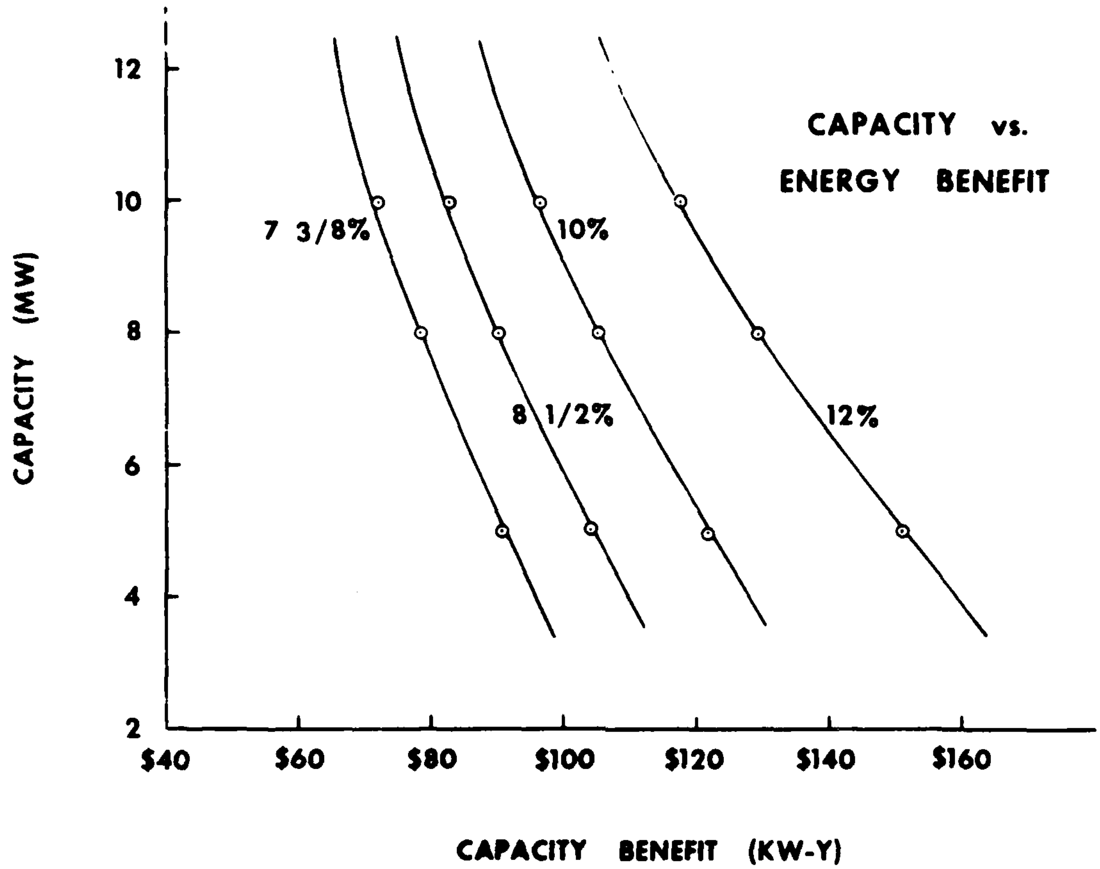
supplied in the FERC evaluation. The capacity benefit was then read from the curves for the 4- and 12-MW options. Similarly, the energy benefit was taken from a capacity versus energy benefit curve. These curves are shown on figure 4.

Table 2 - Power value summary, lock and dam 2, Mississippi River (1 October 1980 cost base and 7 3/8-percent cost of money)

4 kW - 4-unit installation	
Capacity value (based on installed capacity)	$95.90/kW-year
Energy value	
Current fuel costs	
Escalated real fuel costs	22.7/MWh
Annual hydroelectric benefit	
Energy benefit - 27,100 MWh at $22.7/MWh	$615,170
Capacity benefit - 4,000 kW at $95.90/kW-year	383,600
Total annual benefit	998,770
5 kW - 5-unit installation	
Capacity value (based on installed capacity)	$91.25/kW-year
Energy value	
Current fuel costs	13.9/MWh
Escalated real fuel costs	22.8/MWh
Annual hydroelectric benefit	
Energy benefit - 31,000 MWh at $22.8/MWh	$706,800
Capacity benefit - 5,000 kW at $91.25/kW-year	456,250
Total annual benefit	1,163,050
8-kW - 8-unit installation	
Capacity value (based on installed capacity)	$79.00/kW-year
Energy value	
Current fuel costs	13.6/MWh
Escalated real fuel costs	23.1/MWh
Annual hydroelectric benefit	
Energy benefit - 37,500 MWh at $23.1/MWh	$866,250
Capacity benefit - 8,000 kW at $79.00/kW-year	632,000
Total annual benefit	1,498,250

Table 2 - Power value summary, lock and dam 2, Mississippi River (1 October 1980 cost base and 7 3/8-percent cost of money (cont)

10 kW - 10-unit installation	
Capacity value (based on installed capacity)	$72.40/kW-year
Energy value	
Current fuel costs	13.5/MWh
Escalated real fuel costs	22.9/MWh
Annual hydroelectric benefit	
Energy benefit - 40,200 MWh at $22.9/MWh	$920,580
Capacity benefit - 10,000 kW at $72.40/kW-year	724,000
Total annual benefit	1,644,580
12-kW - 12-unit installation	
Capacity value (based on installed capacity)	$66.10/kW-year
Energy value	
Current fuel costs	
Escalated real fuel costs	22.6/MWh
Annual hydroelectric benefit	
Energy value - 41,700 MWh at $22.6/MWh	$942,420
Capacity benefit - 12,000 kW at $66.10/kW-year	793,200
Total annual benefit	1,735,620


CAPACITY vs.
ENERGY BENEFIT
CAPACITY (MW)
12
10
8
6
4
2
7 3/8%
10%
8 1/2%
12%
$40
$60
$80
$100
$120
$140
$160
CAPACITY BENEFIT (KW-Y)

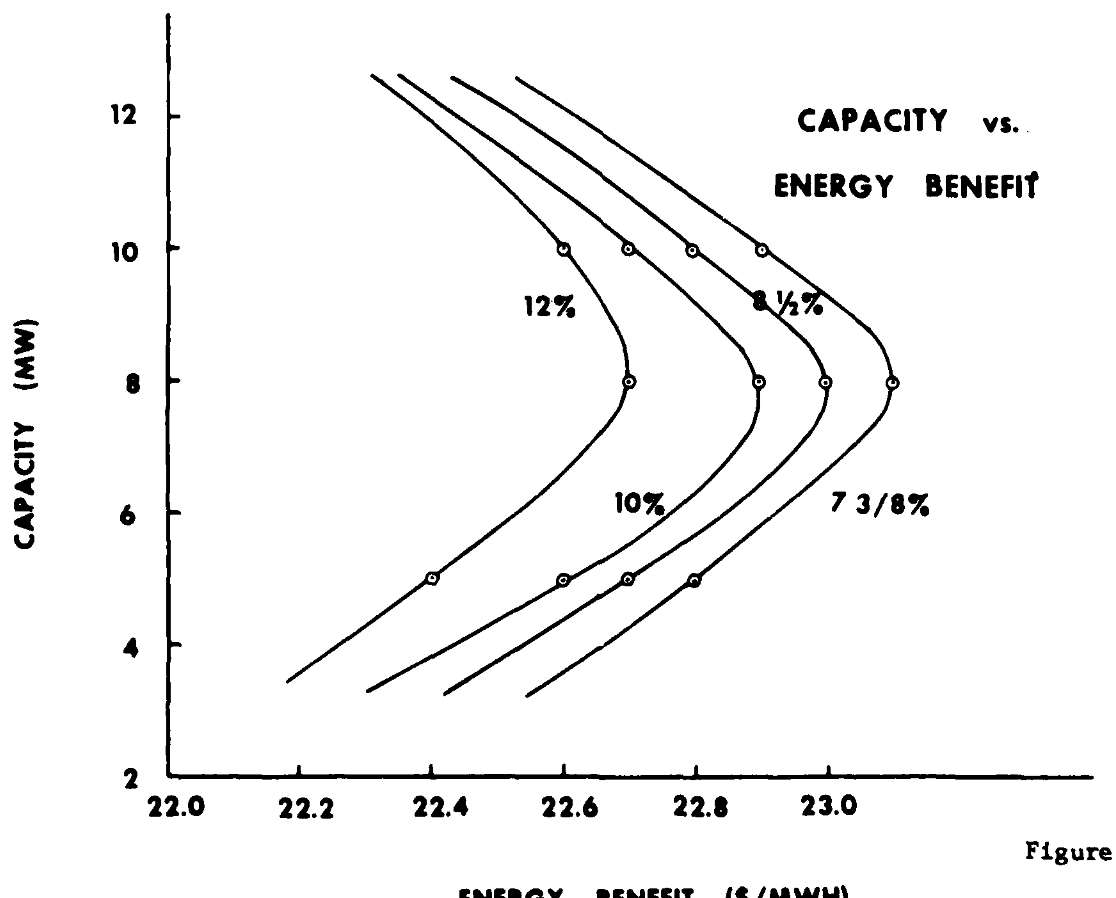

CAPACITY vs.
ENERGY BENEFIT
CAPACITY (MW)
12
10
8
6
4
2
12%
8 ½%
10%
7 3/8%
22.0
22.2
22.4
22.6
22.8
23.0
ENERGY BENEFIT ($/MWH)

Figure 4

Table 3 shows annualized costs and benefits for each of the alternatives.

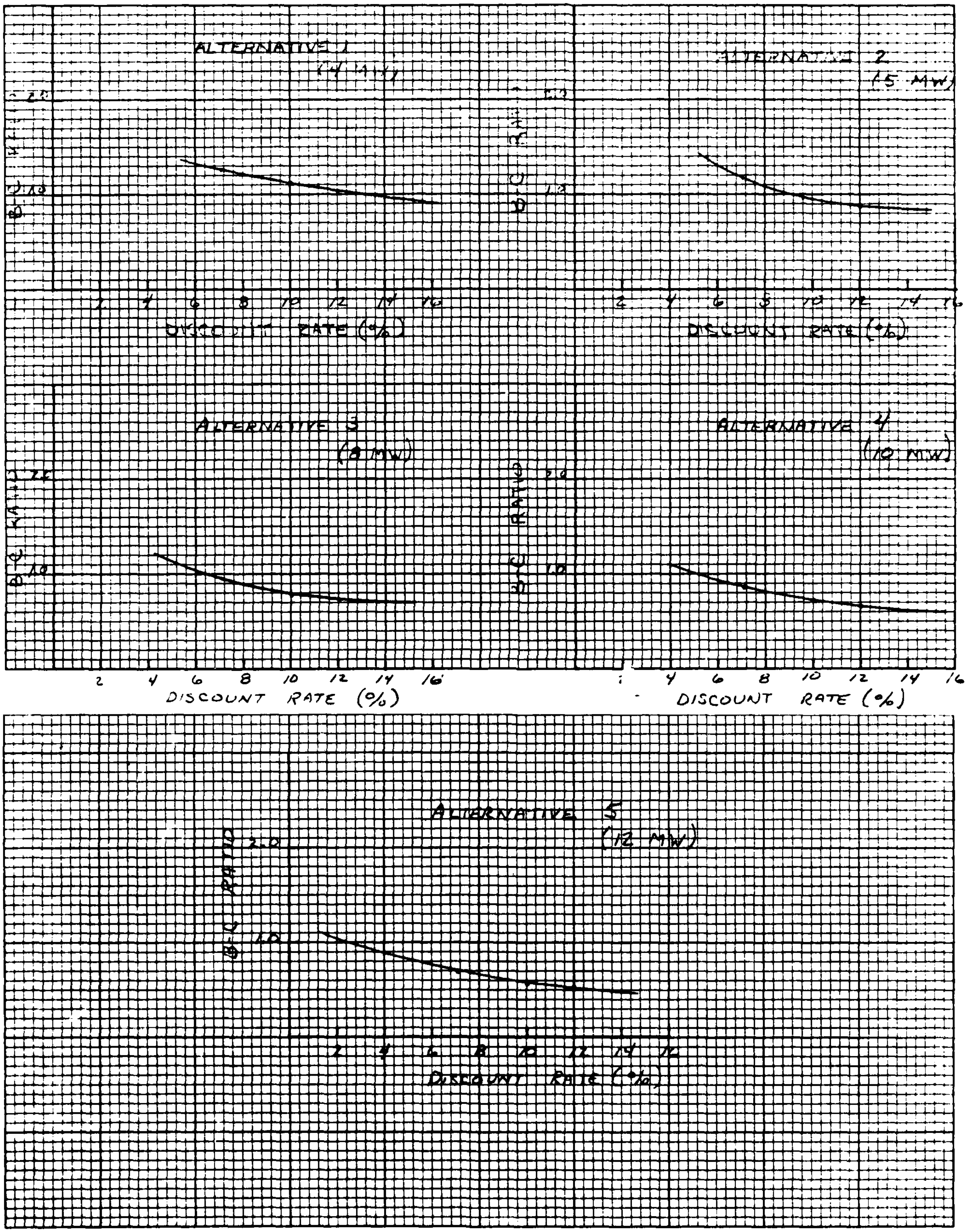
Table 3 - Average annual costs and benefits (1)

Item	Amount ($1,000) Alternative 1 (4 kW)	Alternative 2 (5 kW)	Alternative 3 (8 kW)	Alternative 4 (10 kW)	Alternative 5 (12 kW)
First costs	9,870	12,010	19,180	23,250	30,200
Present worth of deferred costs (2)	40	48	73	88	88
Interest during construction (3)	601	732	1,169	1,417	1,417
Present worth of salvage value (4)	-11	-14	-21	-26	-26
Net Federal investment	10,500	12,776	20,401	24,729	24,729
Average annual charges	775	943	1,506	1,825	2,370
Operation and maintenance	33	43	67	84	102
Total annual costs	808	986	1,573	1,909	2,472
Average annual benefits	999	1,163	1,498	1,645	1,736
Net benefits	191	177	-75	-264	-736
Benefit-cost ratio	1.24	1.18	0.95	0.86	0.70

(1) 7 3/8-percent interest rate, 1980 prices.
(2) Deferred costs are the present worth of the value of costs required for project rehabilitation at year 50.
(3) Considers 2-year construction period.
(4) Considers present worth of the value of salvageable machinery at year 50 and year 100.

As indicated in table 3, both the 4- and 5-MW options have favorable benefit-cost ratios. Net benefits are $191,000 and $177,000 for the 4-MW and 5-MW plants, respectively.

The five alternatives investigated in this report were evaluated to determine the internal rate of return (see figure 5). The internal rate of return for the 4-MW alternative is 13 percent; for the 5-MW alternative, the value was found to be 9 percent.



Internal rate of return, lock and dam 2
(Oct 1980 prices)

Figure 5

ENVIRONMENTAL IMPACTS

No Action Alternative

The no action alternative would not alter existing conditions.

Hydropower Alternatives

It is anticipated that the impacts of the five different alternatives would be quite similar because of the location of each alternative in the same general area. The impacts would vary primarily in magnitude.

Construction Impacts

Impacts of the installation of hydropower would result from the construction of cofferdams, excavation and disposal of earth and concrete, and, possibly, establishing a powerline corridor.

Detailed site plans have not been developed nor have disposal sites been designated. Alternatives which would include installing turbines in the riverward lock would require a substantially greater amount of excavation but no upstream cofferdam. Placing turbines in the spillway dam would require both upstream and downstream cofferdams.

Impacts of excavation and cofferdam construction would include burial or physical removal of benthic habitat and organisms. Recolonization would not be expected to duplicate preproject conditions because of changes in substrate composition and current velocity resulting from excavation and construction. Abundance and community composition of benthic organisms would change. It is a standard practice to protect newly excavated areas from erosion. Riprap is frequently placed under water to stabilize or protect banks. Riprap will provide habitat for benthic invertebrates usually with greater surface area available than that which it covers or replaces. Different species would use the hard substrate. Excavation may also destroy or alter tail-water fish spawning and foraging habitat.

Cofferdams would shift river currents during construction. Water would not flow over the spillway dam and so current velocities would increase slightly through the operating gates. The riverward lock has not been operated since 1948 so construction would not affect lock operations or water currents.

It is not known as yet whether a new corridor would be needed for transmission lines. It may be possible to use existing corridors. In that case, routing the power to the existing lines may require cutting of trees and brush and disturbance of the soil. New transmission lines would probably be longer than the connections to existing lines and more likely to impact woodland and wetlands.

Impacts of Operation

It is planned that hydropower be operated as a "run of the river" installation. Therefore, no alteration of the present water level regime would be expected to result from the operation of the units. No erosion would be expected from altered current patterns because areas that would be subject to increased current velocities would be protected with riprap.

Changes in flow patterns would occur. A substantial portion of the river flow would be routed through the turbines whenever sufficient head (difference in pool levels) would be available to operate the turbines. At certain times, late summer and winter, essentially all of the flow would pass through the turbines. Naturally, the greater the number of units installed, the greater the diversion of flow. The flow would be concentrated on the west (right) side where the locks are located. Current velocities would increase in the tail water below the turbines, while a decrease would occur below the tainter gates. Bottom contours would be altered below the turbines and substrate would be changed from the natural material to riprap. These changes would affect the fishery community in the tail water area and alter the availability of habitat for spawning, an important function of the tail water area. The extent to which these changes would affect fish populations is unknown and would require investigation later in the planning process.

Operation of the turbines is not expected to significantly affect water quality. Water depths are not sufficient to cause gas supersaturation problems. However, the diversion of water from the tainter gates to the turbines could result in a reduction in the aeration action of the dam. Lock and dam 2 is presently operated to increase the aeration of the water carrying a high organic load from the Metropolitan Sewage Treatment Plant. It would be necessary to determine the degree of reduction which could occur, and investigate the possibility of aeration of the water as it leaves the turbine.

The clearance between tube and blades and the relatively slow speed of the runners should permit the survival of most fish, eggs, and larvae that are entrained by the units. Impingement would not be anticipated as a serious problem because of the absence of intake bays or other physical barriers to lateral escape by fish at the intakes of the turbines. Fish would not be retained by the relatively widely spaced bars of the trash rack. Approach velocities, which to a large degree determine the amount of entrainment of adult fish, have not been calculated at this stage.

Fish, including sauger and white bass, are known to move upstream and downstream. It is likely that closure of dam gates would, at times, restrict movement of fish but the extent of this restriction and the impact of restricted movements are not known at this time.

If it would be necessary to cross the river with transmission lines, then detrimental effects on migratory birds, and waterfowl in particular, would be expected. Migrating birds collide with the transmission wires. The extent of these collisions has not been estimated. It is necessary to maintain transmission line corridors free of trees and large shrubs to prevent electrical arcing from the line to the trees or shrubs. Wildlife habitat would be permanently lost in the right-of-way.

Social Impacts

The social impacts of project completion will most likely be accentuated due to the proximity of Hastings with the construction site. The social impacts of powerhouse construction will include effects on employment, community services, safety and health, noise and air pollution, and local transportation. The social impacts of transmission line placement depend to a degree on the orientation of placement. The social consequences associated with placement of transmission lines and corridors potentially include property acquisition, structure relocation, disruption of community cohesion, reduced visual aesthetic quality, and inequitable distribution of project benefits and costs. The present project is expected to take advantage of preconstructed corridors for line placement and, therefore, will avoid the necessity for property acquisition and structure relocation. Since the market for power is likely to be local, from the Twin Cities SMSA and Hastings specifically, the distribution of project benefits and costs is expected to be fairly equitable. The most significant social impact will be noted in reduced visual aesthetic quality, especially if the transmission line is placed west across the Mississippi River. Such a placement may also prove to be incompatible with present resource uses, fish and wildlife management, and recreation. Such an orientation may also result in further negative consequences stemming from corridor placement.

Cultural Resources Impacts

Essentially the entire proposed construction area for the installation of the turbine units has been disturbed by construction of lock and dam 2. The only standing structure within the proposed project area that would be impacted is the lock and dam structure itself.

Further impact assessment will be accomplished as powerlines and other construction features associated with the installation of the turbines are identified.

Coordination has been initiated with the State Historic Preservation Officer, the Minnesota State Archeologist, and the National Park Service Cultural Program.

Impacts of Hydropower Development at Lock and Dam 2 on Recreation

The most significant impacts on recreation users and resources to be generated by the project are assumed to be directly related to the discharge of the turbines. The potential impacts on fisheries have been discussed. The altered tail-water flow patterns could create boat safety problems which must be addressed in future studies.

Since the lock would continue to operate during construction, recreational lockages would not be affected. Fishing around lock and dam 2 is relatively low compared to downstream lock and dam areas. However, because of the proximity of lock and dam 2 to the Twin Cities area, the potential exists for this area to become an important site for sport fishing. Improvements to current recreation use at the site might result if planned for during project construction. These actions include fish habitat improvements in the discharge area and improvements to bank fishing access.

Presently, an overlook for the public to view locking operations exists at lock and dam 2. Signage interpreting the hydropower operation could possibly be added to this facility.

HYDROLOGIC POWER AND ENERGY ANALYSIS OF ALTERNATIVES

Following is a shortened discussion of the hydrologic power and energy analysis found in appendix C of this report. For further information and location of plates mentioned below, consult appendix C.

Average Annual Energy

The power capacity and energy production for run-of-river plants can be adequately predicted from the flow-duration curve. Daily flow values for the period of record are grouped into flow classes. Each flow class is then plotted according to its cumulative percentage of occurrence. The result is the flow-duration curve shown in figure 6.

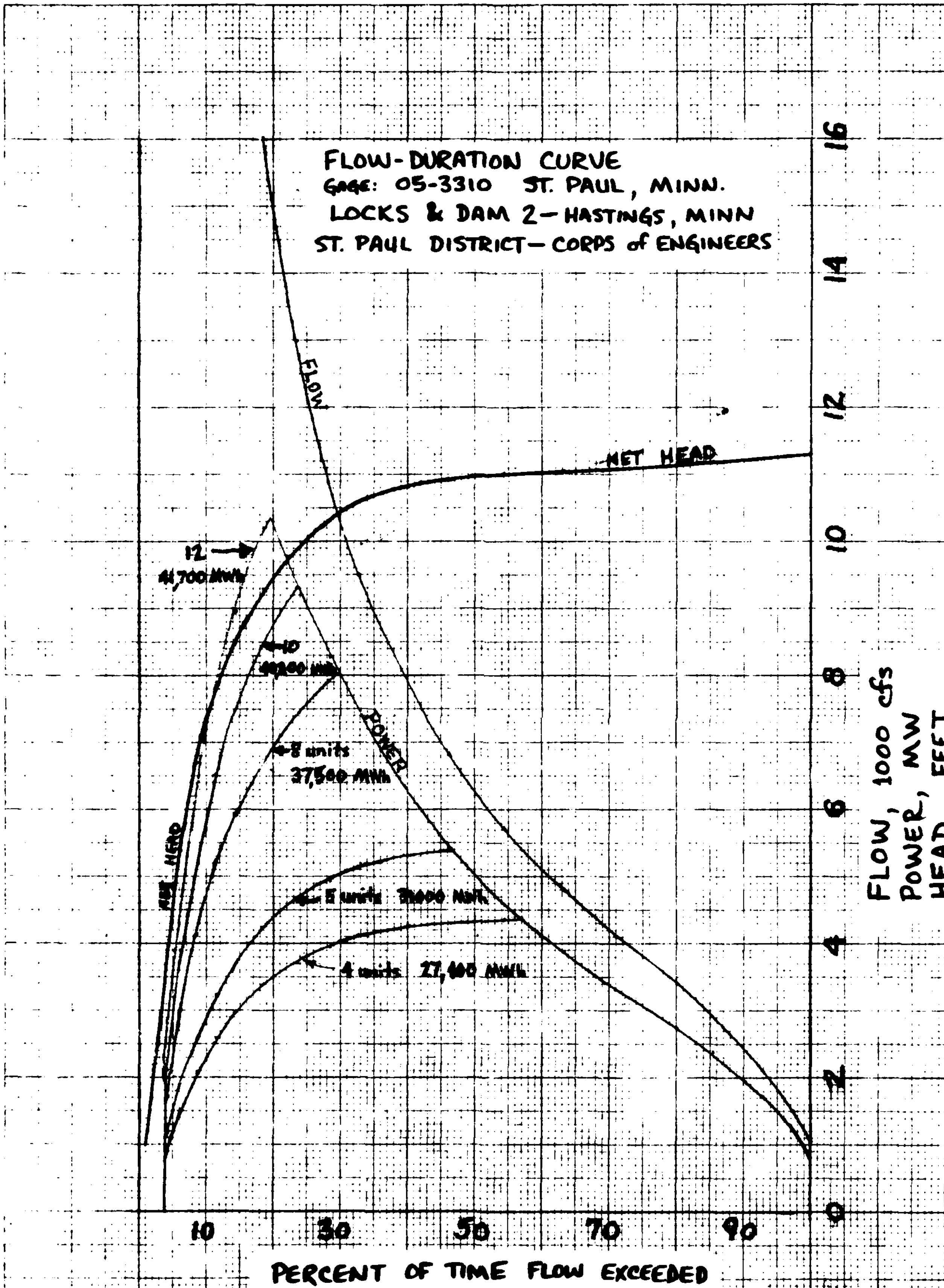

FLOW-DURATION CURVE
GAGE: 05-3310 ST. PAUL, MINN.
LOCKS & DAM 2—HASTINGS, MINN
ST. PAUL DISTRICT—CORPS of ENGINEERS
FLOW
NET HEAD
POWER
12
41,700 MWh
10
8 units
37,500 MWh
5 units
4 units 27,400 MWh
NET HEAD
0
2
4
6
8
10
12
14
16
FLOW, 1000 cfs
POWER, MW
HEAD, FEET
10
30
50
70
90
PERCENT OF TIME FLOW EXCEEDED

FIGURE 6

Higher flows cause a reduction in the available head at lock and dam 2. This variation is taken into account in the energy calculations. The gross head was reduced by the estimated trash rack and tailrace losses to produce the curve of net head shown on figure 6. Each flow class is assigned an average head for the class. The product of the head and flow gives the power; the power is then multiplied by the duration of the flow class (in hours) to find the estimated energy. The power values are also plotted on figure 6 for each option. Summation of the energy of all the flow classes, i.e., the area under the power curve, gives the average annual energy (AAE) for each option.

Our investigation, using a refined head versus flow curve, resulted in somewhat lower values for average annual energy than the Allis-Chalmers estimates:

Number of units	Size	Vane angle	Average annual energy
4	3.0 meters	B	27,100 MWh
5	3.0 meters	B	31,000 MWh
8	3.0 meters	B	37,500 MWh
10	3.0 meters	B	40,200 MWh
12	3.0 meters	B	41,700 MWh

The above units all use inlet vane angle B, which provides more power per dollar invested in machinery, at a slightly lower mechanical efficiency. Since machinery costs are a major portion of low head projects, this is the more cost-effective route to follow.

Average Weekly Generation

The Federal Energy Regulatory Commission (FERC) used a computer program to estimate benefits attributable to the project. The program requires average weekly generation values as input. Average weekly generation values were developed for each option. Appendix C discusses the method used to arrive at these weekly values. Plate C-6 shows the average weekly generation.

Firm Power Evaluation

During July-August and December-January each year, power demand is high, and the reliability of capacity is critical. To evaluate the capacity of the various options during these critical periods, power-duration curves for July-August and December-January for the period of record were developed. By using these curves (plates C-3 and C-4), firm power values were determined for various options, and these are shown in table 4.

Table 4 - Firm power (MW) for lock and dam 2

Period	Option				
	4 MW	5 MW	8MW	10MW	12 MW
July-August	3.7	4.5	5.7	6.2	6.6
December-January	3.1	3.8	4.0	4.1	4.1
All year	3.6	4.2	5.1	5.5	5.6

One interesting feature of this project is that the original design pool was at elevation 691.1. This was lowered by court order in 1934 to 689.2 after the structure was built. If it were feasible to raise the pool to the original design level before installation of hydropower machinery, an additional 1.9 feet of head would be obtained. This would result in an increase in generation benefits of 15 to 18 percent. Other benefits would include reduced dredging requirements and an improved channel depth at the tail water of lock 1.

The data for the flow-duration analysis are shown in Appendix C, Hydrologic Power and Energy Analysis. Also included in appendix C are sections for average annual energy, firm power analysis, and average weekly generation.

MECHANICAL AND ELECTRICAL FEATURES

General

A standardized packaged predesigned turbine-generator, tubular type, would meet the hydraulic conditions at this site. Plate 2 illustrates the adaptation of information furnished for the Allis-Chalmers predesigned units. The units selected would be capable of delivering 1,000 kW each with a rated head of 10.5 feet. The major equipment furnished as part of each package would include generator, turbine, control panel, cubicle for metering equipment, intake gate speed increaser, coupling, blade positioner, and oil system.

Intake Structure

As indicated in alternatives 1 and 2, the spillway dam would be considered as a possible location of a 4- or 5-kW hydropower development at lock and dam 2. In addition, the riverward lock would also be carefully considered as a possible location.

Mechanical Equipment

The on-off control of intake water would be by a tainter gate. The gate would be equipped for emergency closure upon loss of power. The operator would be arranged to lower the gate against full turbine runaway speed discharge. The bulkhead slots would be used if the operating gate requires maintenance.

An overhead bridge crane would be considered for maintenance of the turbines and generators. This would allow inspection of the runners without the need for a mobile crane.

Standard ceiling-type exhaust fans would be provided for powerhouse cooling. Because the generators are air cooled, the fans would be sized to maintain temperature limits using outdoor air only.

Two small submersible pumps would be provided for drainage and dewatering. Portable pumps could also be used for dewatering.

Turbine

An adjustable three-blade tubular turbine available from several manufacturers is considered because it is the largest standardized package unit which will fit the existing structure. The turbine has a throat diameter of 3,000 millimeters (118.1 inches). As shown in figure 7, at a rated head of 10.5 feet, generator output of the unit can be estimated at 1,100 kW. To account for possibly lower than advertised efficiencies and mechanical and transmission losses, an output of 1,000 kW per unit was adopted.

Other turbines, such as bulb turbines and "Ossberger" cross-flow type turbines, may be suitable for this installation. All suitable turbine types will be evaluated during the feasibility study.

Generators and Breakers

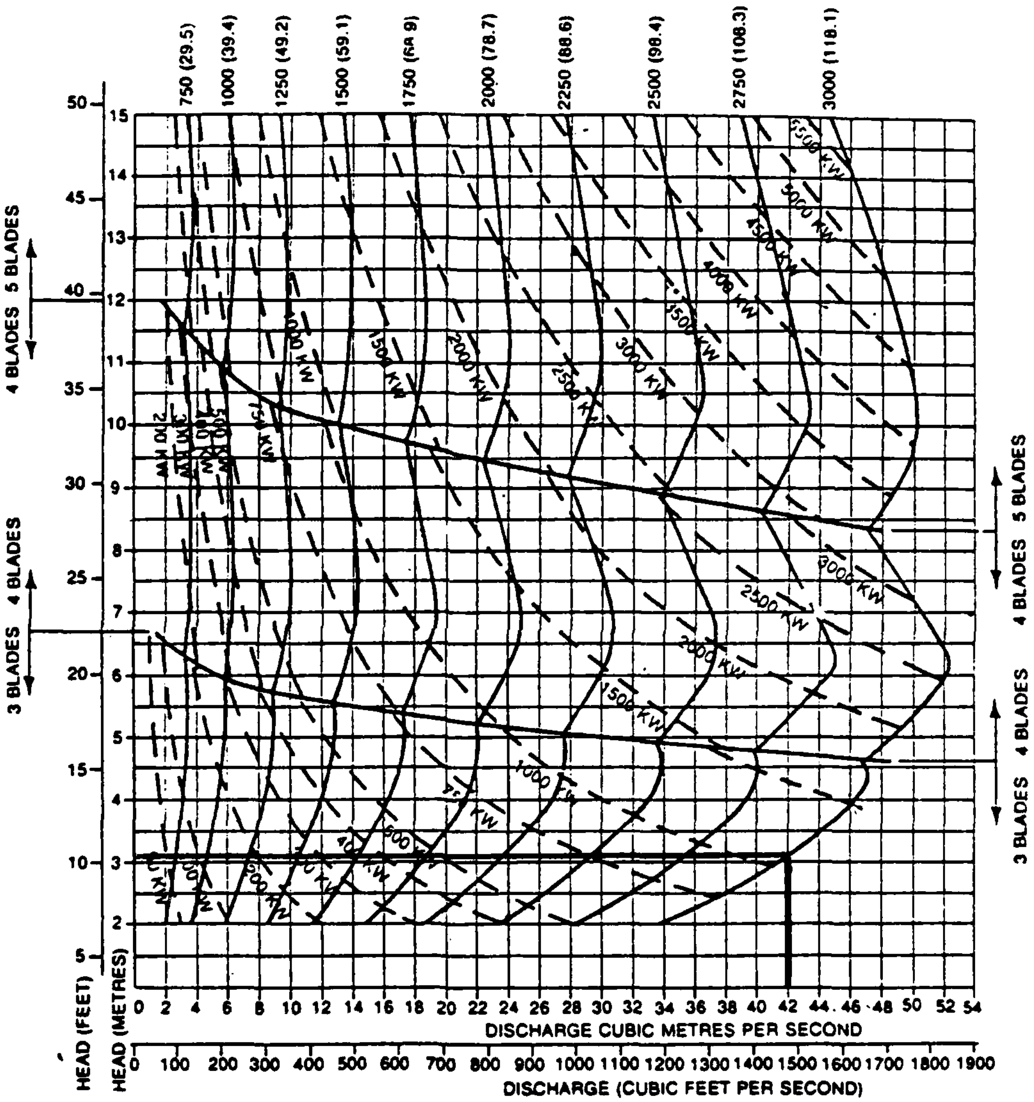
The generator would be a synchronous type, rated 1,100 kVA, 0.1 PF, 3-phase, 60 Hz, 4.16 kV, 900 rpm. A drip-proof guarded enclosure would be provided for the generator. The generator would have an 80^{o} rise, class B insulation system without provisions for overload. It would have full runaway speed capability eliminating the need for a disconnect clutch. The generator breaker will be a metal clad drawout type rated 250 MVA (nominal), 5 kV, 1,200 amp continuous. Breakers will be combined into metal clad switchgear lineups common to groups of two units, also containing generator surge protection and instrument transformers as well as station service switchgear in two of the lineups.

Excitation System

The excitation system for the unit would be of the bus-fed, power potential source, static type, excitation power being derived from the generator terminals. During starting, the generator field will be automatically flashed (permitting generator voltage buildup) from a rectified A-C station service source.

Sizing Chart

STANDARD *TUBE* TURBINE UNITS
OPERATING RANGES
750 mm to 3000 mm
GENERATOR OUTPUT IN KILOWATTS
TEN UNIT SIZES — MILLIMETRES (INCHES)



NOTE: OUTPUT BASED ON UNIT CENTERLINE SETTING OF ONE-HALF (½) RUNNER DIAMETER (DIA/2) ABOVE TAILWATER. CENTERLINE OF UNIT AT ELEVATION 150 m (500 ft.) ABOVE SEA LEVEL

FIGURE 7. GENERATOR SIZING CHART

Source; Figure 9 from <u>Standardized Hydroelectric Generating Units</u> by Allis-Chalmers.

Unit Control and Protective Equipment

A complete complement of generator protective relays (differential, overvoltage, overcurrent, etc.), start-up and shut-down controls and other unit control relays would be provided in the metal-clad switchgear lineup containing the generator circuit breaker. Synchronizing would be accomplished by speed switches. The generator breaker would close at 95-percent speed with the static excitation system being energized at 98-percent speed. The generator would be provided with connected amortisseur to facilitate pull-in with the system. The packaged unit would have electrical and mechanical protective devices as indicated on the one-line diagram of figure 8.

Station Service

There would be two separate sources of station service power. One source would be bus tap between two generator circuit breakers and a main power transformer, and from a similar tap from the second bus as shown on figure 8. Station service switchgear would be arranged to provide full service from either source. Also, the former above source would supply station service from a single unit when generation into the utility system is shut down. Station service switchgear (4,160 volts) would be included in generator circuit breaker switchgear lineups. Station service power distribution would be a 480 volts 3-phase and 120/240 volts single phase.

Connection to Load

4-Unit Station - A 3-phase 69 kV overhead transmission line would tie directly to the local utility substation. The substation is approximately 3 miles from the powerhouse site. The plant would have two generator step-up transformers with two units connected to each transformer. Each transformer would be rated 2,500 kVA, 69 kV "WYE" connected high-voltage winding, 4.16 kV "DELTA" connected low voltage winding, 3-phase, 60 Hz. The transformers would be bused together on the high-voltage side through disconnect switches at the powerhouse for connection to the transmission line.

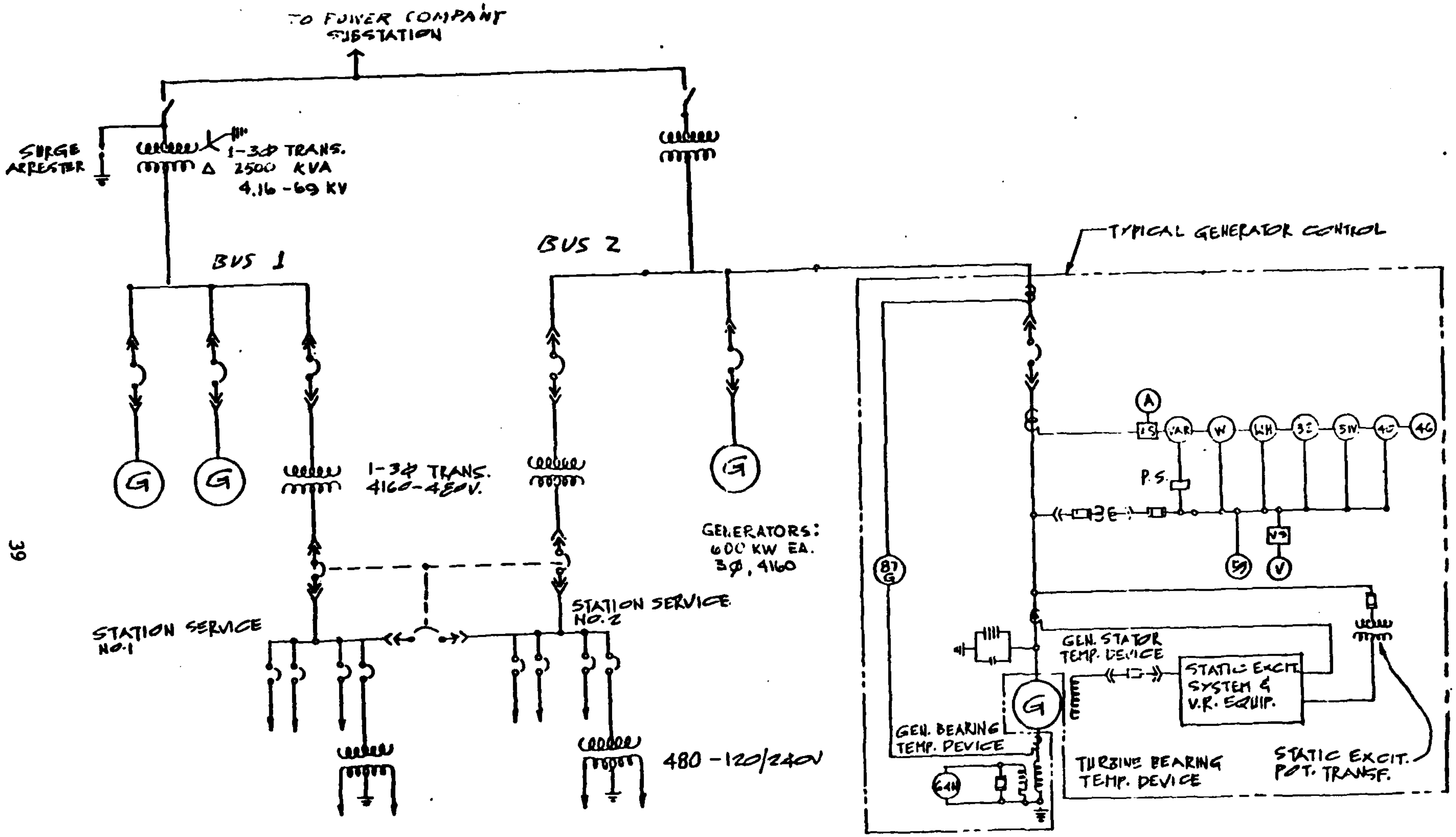


FIGURE 8: MAIN ONE LINE DIAGRAM - L&D No. 2 HYDRO STATION

NOTE: FOR 5 UNIT STATION ADD 1 GENERATORS TO BUS/AND INCREASE TRANSFORMER TO 3750 KVA.

5-Unit Station - For a 5-unit station, three generators would be connected to each BUS No. 1. The step-up transformer would be rated at 3,750 kVA for the 3-unit feeder.

CIVIL FEATURES

This section describes the civil features pertaining to the installation of tube turbine generating units at lock and dam 2. Civil features include the powerhouse, intake and discharge channels, impact on existing structures, and permanent access. A description of proposed dewatering procedures is also included.

Powerhouse

The powerhouse (alternatives 1 and 2) or powerhouses (alternatives 3, 4, and 5) would be made of reinforced concrete and would house the power generating units and electrical equipment. Sheet-pile cutoff walls would be driven at the upstream and downstream edges of the powerhouse to prevent undermining of the structure. Batter piles would be installed as part of the powerhouse foundation to provide the resistance necessary to prevent the structure from sliding downstream. Trash racks would be installed upstream and downstream of the turbines. Upstream trash racks would have small openings to protect the turbines from damage during operation. Downstream trash racks would have large openings to prevent debris from entering the turbines during flood conditions. Flow to the turbines would be regulated by tainter gates installed upstream of the units. Stop-log grooves would be provided on the upstream and downstream edges of the structure so that the turbines could be dewatered for maintenance.

Lock 2 was overtopped during the 1965 flood. The top elevation of the lock is 694.1 and the maximum water elevation reached by the 1965 flood was 697.07. Floodwater entering the powerhouse would damage the electrical equipment and the dirt carried by the floodwaters would require that the mechanical equipment be cleaned. To prevent floodwater from entering the powerhouse, walls with a top elevation of 698.0 would be constructed around the control station (see plate 2). The control station is the portion of the powerhouse which houses the mechanical and electrical equipment.

Three powerhouse locations were studied. Turbines are placed in one or more of the locations to create alternatives. The interior dimensions and layout of equipment are identical for each powerhouse location. The width of the powerhouse would change if four turbines instead of five turbines were installed at a location. The length of the powerhouse and the positioning of the equipment would be the same for the four- or five-turbine powerhouse. At the lock chamber location and at the between the locks location, the powerhouse is located at the downstream end to minimize excavation and potential lock wall foundation problems caused by installation of the powerhouse.

Channels and Stilling Basins

Turbine operation at the spillway dam location would require the excavation of intake and discharge channels. The channels would be riprapped to provide protection against scour. Channel alignment and riprap extent are as shown on plate 1. A sheet-pile cell structure is proposed to accommodate the elevation difference between the bottom of the discharge channel and the downstream sill of the end gate.

Turbine installation in the river lock location would require the placement of riprap upstream and downstream of the lock to provide additional scour protection.

Installation of the turbines in the between the locks location would include the placing of riprap upstream and downstream of the powerhouse. To allow flow to reach the turbines, the existing river lock guidewalls would have to be removed. To provide protection to navigation from possible adverse currents, new guidewalls would have to be installed upstream and downstream of the land lock as shown on plate 1.

Table 5 shows a 42-inch riprap gradation. A 42-inch layer thickness would be used in all locations.

Table 5 - Riprap gradation of the 42-inch layer thickness

Percent lighter by weight	Limits of stone weight in pounds	
	Maximum	Minimum
100	1,098	439
50	463	220
15	232	69

The analysis for the riprap design considered average inlet and outlet velocities, the possibility of flow concentration, and the possibility of a local increase in shear stress at channel transitions such as elevation changes in the approach channels to the turbines.

Impact on Existing Structures

Installation of a four- or five-turbine powerhouse at the spillway dam location would affect the spillway dam and the river wall of the river lock. The riprap-filled timber cribbing downstream of the spillway dam foundation would be removed. The existing concrete foundation for the spillway dam would remain intact and be used as part of the powerhouse foundation (see plate 2). If the five-turbine powerhouse is constructed, approximately 8.5 feet of the riverside concrete spillway pier would be removed above the foundation. The riverward spillway pier foundation would be used as part of the powerhouse foundation. The invert elevation of the outlet channel is below the bottom of the lock wall concrete, requiring that sheet-piling be driven to prevent the erosion of material from beneath the lock wall. To accommodate cofferdam construction, at least two tainter gates adjacent to the spillway dam would have to be closed during construction of the powerhouse.

Powerhouse installation in the river lock would require modification to the lock. The invert elevation of the outlet channel is below the bottom of the lock wall foundations exposing the timber pilings to possible scour. Sheet-pile will be driven in the outlet channel and powerhouse areas to protect the timber piles. The lock chamber floor will have to be removed for the powerhouse and outlet channel as the discharge invert elevation is below the present lock chamber floor elevation. The lock chamber floor upstream of the powerhouse will be left intact to provide an armored intake channel for the turbines. The downstream gate sill and the rock-filled timber cribbing downstream of the gate sill will have to be removed as they are located in the proposed outlet channel. Existing upstream and downstream miter gates and operating machinery will have to be removed to allow installation of the powerhouse.

Installation of the turbines between the locks has impacts on several adjacent structures. To protect the lock wall foundations against potential scour, sheet-piling will be driven at the powerhouse and outlet channel locations. The removal of the fill from between the lock walls will have a beneficial effect on the lock wall stabilities as it will be replaced by water at a higher elevation. During construction, however, special precautions will have to be made to assure that the integrity of the lock walls is not compromised, as the construction will be done in the dewatered condition. The downstream river lock guide wall will have to be removed to provide a flow path downstream of the powerhouse. The upstream cutoff wall will have to be removed to allow flow to reach the turbine. Upstream of the powerhouse, the existing fill between the locks would have to be removed to provide an intake channel for the turbines. Other nonstructural impacts include the relocation of an existing riprap stockpile between the locks and possible effects on river traffic upstream of the land lock from flow being drawn by the turbines. The upstream and downstream guide walls were extended to provide protection for navigation from objectionable or hazardous currents that would be generated by powerhouse operations.

Geotechnical

Available subsurface data at the proposed hydropower sites is limited to borings taken for construction of the landward lock in 1937. Typical boring logs from this investigation are shown on plate 3. These boring logs show the foundation soils under the riverward lock and spillway dam to consist of a 30-foot layer of dense medium sand overlying a 60-foot layer of clay and silt. A 25-foot layer of silt and sand lies atop the medium sand stratum in the area between the two locks.

The major foundation concern is to preclude movement between the hydropower plant and the existing lock and dam structures and thereby retain the integrity of the seal between structures. Construction of the hydropower plant between the two locks will require the excavation of approximately 35 feet of silt and sand. Since the effective weight of this removed overburden is almost equal to the proposed applied footing load (2,200 psf vs. 2,100 psf), few problems with settlement or rebound are anticipated. The riverward lock and spillway damsites have similar foundation and loading conditions and were analyzed together. The effective overburden weight at these sites was calculated to be 750 psf, reducing the applied footing load to 1,350 psf. The additional stress applied to the deep underlying clay and silt layer from this footing load was calculated using Westergaard's theory for the sand layer and was found to be insignificant in respect to settlement in the silt and clay layers. From all indications, the medium sand layer which the spread footings will be constructed upon will adequately support the structure without serious settlement.

Additional borings and testing will be scheduled in the next design phase to permit a more complete assessment of settlements either due to machine vibrations or static loadings and stability of hydrounits. The subsurface information will also be used to formulate a dewatering plan for construction.

Access

It is assumed that Corps personnel will operate and maintain the powerhouse. If Corps personnel do operate and maintain the powerhouse, no special access needs to be provided. If the powerhouse is not operated and maintained by the Corps, a method of access to the powerhouse will have to be provided.

Dewatering

The area around the powerhouse will have to be dewatered for the construction of the powerhouse. To accomplish the dewatering, different methods will be used at the different locations.

Earth cofferdams will be used upstream and downstream at the spillway dam location. The gates adjacent to the spillway dam would be closed during construction of the powerhouse to provide the necessary space required for cofferdam tie-in. The other end of the cofferdams will tie into the river wall of the river lock.

For powerhouse construction in the river lock, the upstream A-frames used in dewatering the lock for maintenance purposes would be used. An earth cofferdam would be used on the downstream end as the powerhouse would be located over the sill used in installing the downstream A-frames.

For construction of a powerhouse between the locks, no cofferdams are needed since the cutoff wall on the upstream end can be removed after the powerhouse is constructed. The fill between the locks provides a cofferdam at the downstream side as the powerhouse would be located far enough upstream of the edge of the fill so that a cofferdam would be left after the excavation for the powerhouse is completed.

All locations will require deep wells and well points to handle seepage into the powerhouse excavation.

CONCLUSIONS

This reconnaissance report establishes that hydropower development is technically feasible at lock and dam 2. Secondly, the report illustrates the economic feasibility of the hydropower on a 4- or 5-megawatt scale. This economic feasibility may be positively affected by new technologies and future high cost of alternative energy sources, enabling a larger scale

of hydropower development to become economically justified. Finally, this report finds that significant environmental damage likely would not be caused by hydropower development at lock and dam 2. A definite conclusion concerning environmental impacts of a hydropower development cannot be made until futher studies are completed.

PLAN FOR FUTURE STUDY

The favorable economic feasibility finding of the reconnaissance study indicates that further detailed study (a feasibility study) is justified.

If a feasibility study is undertaken, it would be designed to formulate a viable small hydropower project, design an implementation strategy, and provide the basis for an implementation commitment. The significant institutional, engineering, environmental, marketing, economic, and financial aspects will be defined, investigated, and assessed in support of the investment decision.

A feasibility report is a decision document that defines and recommends a course of action. The finding of a feasibility report is whether a commitment to implement is warranted. If the finding is positive, the report defines the steps necessary for implementation. A positive economic feasibility finding is normally necessary for implementation. However, other concerns can be equally important in serving the broad public interest, and the feasibility study would be performed in the modern spirit of wise natural resource management and the multiobjective planning process.

The feasibility study, if approved, would begin in fiscal year 1983. The final feasibility report is scheduled for completion in fall 1984. After completion of the District's report, the report would be sent forward to higher Corps echelons for review, comment, approval, and final submission to Congress for authorization of the recommended plan.

The level of detail envisioned for the feasibility study would be sufficient for direct development of plans and specifications for project implementation. Assuming prompt funding following congressional authorization, the plant would be completed 3 to 4 years after allocation of construction funds.

Revised 10 Feb 82

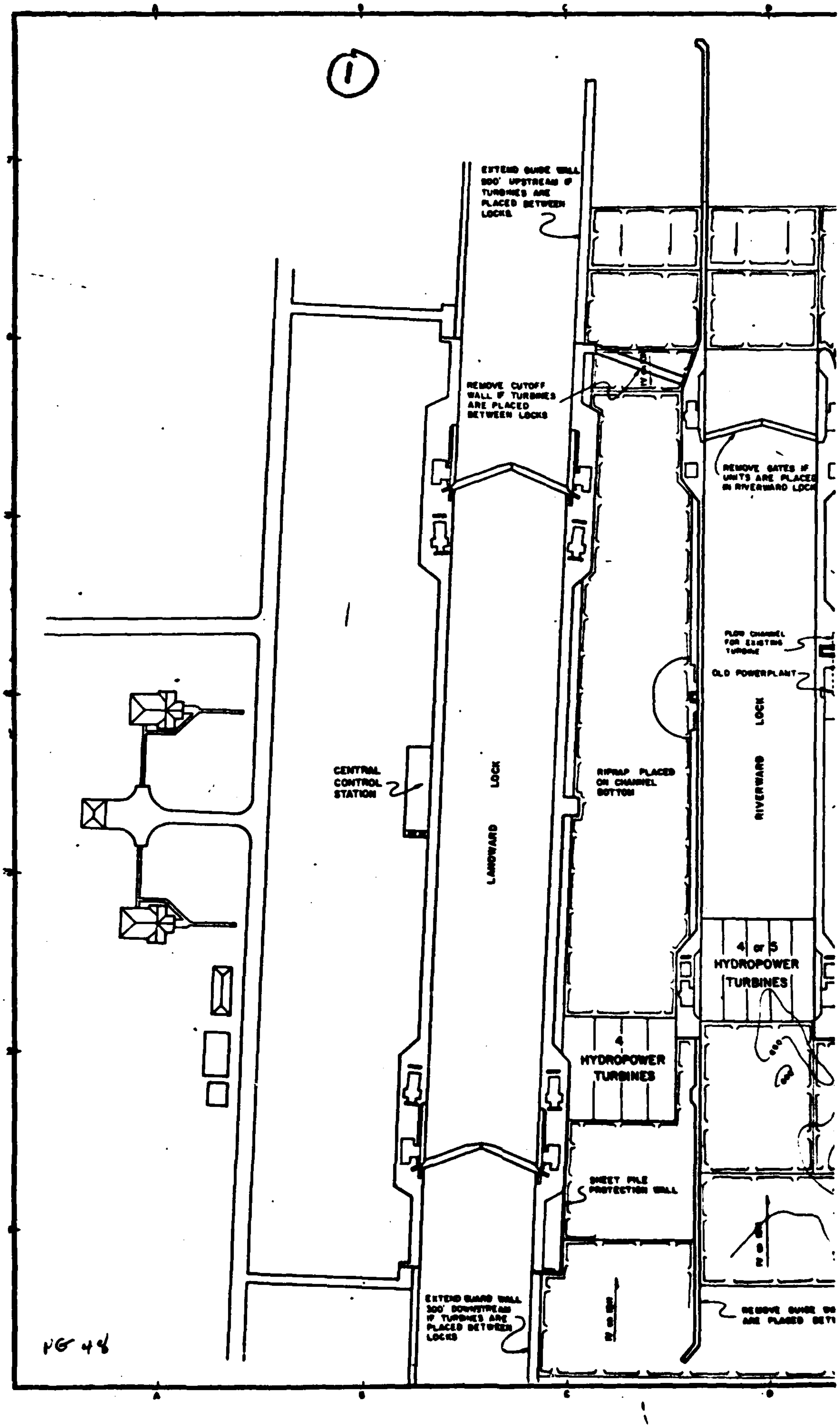
Appendix D outlines in detail a plan of study for the lock and dam 2 feasibility investigation.

RECOMMENDATION

I recommend that a feasibility report be prepared and that it be allowed to begin in fiscal year 1983. I further propose that the report be comprehensive enough so that it can be used as a basis for construction authorization by Congress and that the feasibility report be completed within 2 years.

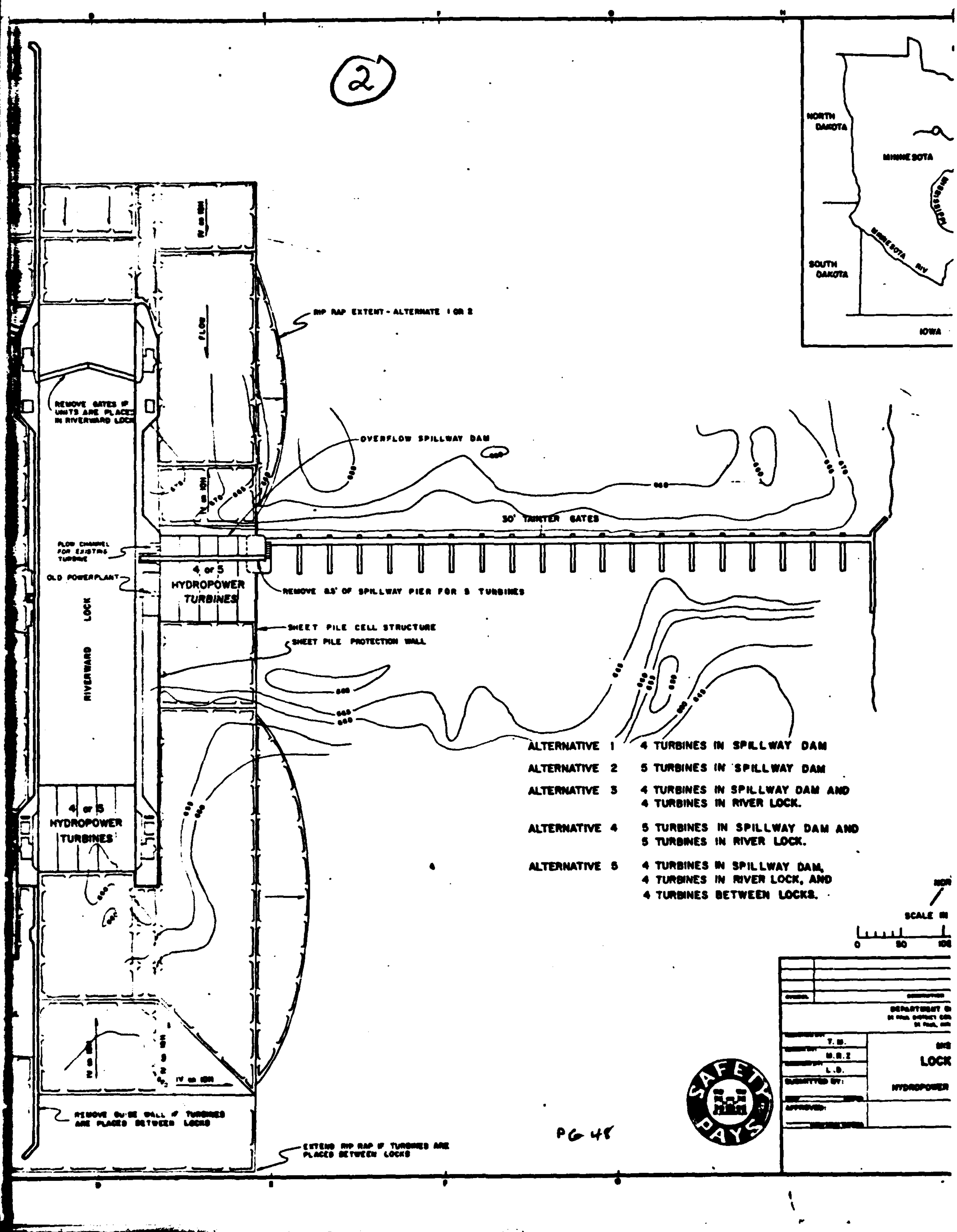
WILLIAM W. BADGER
Colonel, Corps of Engineers
Commanding

Revised 10 Feb 82

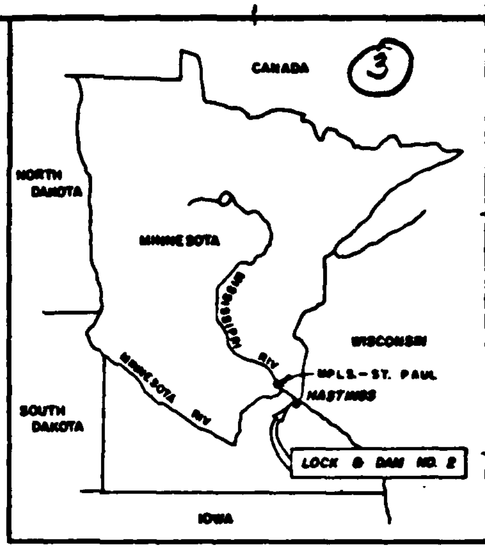


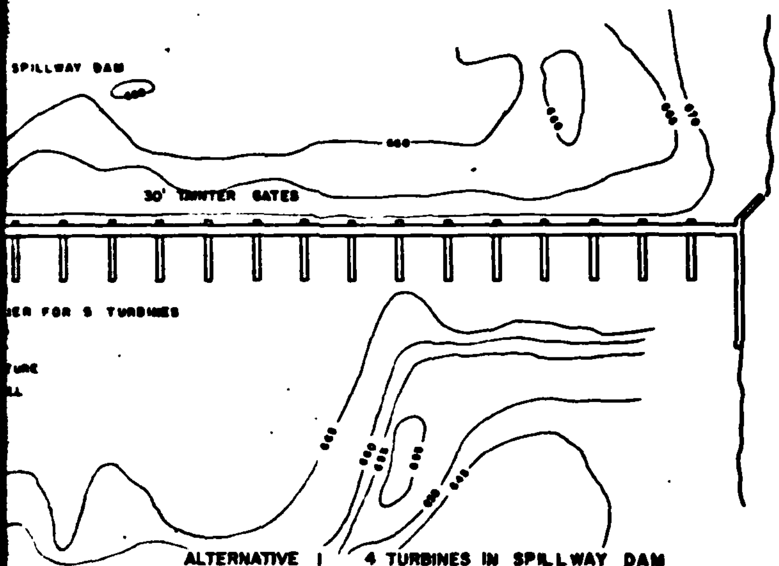
1
EXTEND GUIDE WALL 300' UPSTREAM IF TURBINES ARE PLACED BETWEEN LOCKS
REMOVE CUTOFF WALL IF TURBINES ARE PLACED BETWEEN LOCKS
REMOVE GATES IF UNITS ARE PLACED IN RIVERWARD LOCK
FLOW CHANNEL FOR EXISTING TURBINE
OLD POWERPLANT
CENTRAL CONTROL STATION
LANDWARD LOCK
RIPRAP PLACED ON CHANNEL BOTTOM
RIVERWARD LOCK
4 or 5 HYDROPOWER TURBINES
4 HYDROPOWER TURBINES
SHEET PILE PROTECTION WALL
EXTEND GUARD WALL 300' DOWNSTREAM IF TURBINES ARE PLACED BETWEEN LOCKS
A
B
C
D

NG 48



(2)
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
MINNESOTA RIV
IOWA
FLOW
RIP RAP EXTENT - ALTERNATE 1 OR 2
REMOVE GATES IF UNITS ARE PLACED IN RIVERWARD LOCK
OVERFLOW SPILLWAY DAM
30' TAINTER GATES
FLOW CHANNEL FOR EXISTING TURBINE
OLD POWERPLANT
4 or 5 HYDROPOWER TURBINES
REMOVE 8.5' OF SPILLWAY PIER FOR 5 TURBINES
SHEET PILE CELL STRUCTURE
SHEET PILE PROTECTION WALL
RIVERWARD LOCK
ALTERNATIVE 1 4 TURBINES IN SPILLWAY DAM
ALTERNATIVE 2 5 TURBINES IN SPILLWAY DAM
ALTERNATIVE 3 4 TURBINES IN SPILLWAY DAM AND 4 TURBINES IN RIVER LOCK.
ALTERNATIVE 4 5 TURBINES IN SPILLWAY DAM AND 5 TURBINES IN RIVER LOCK.
ALTERNATIVE 5 4 TURBINES IN SPILLWAY DAM, 4 TURBINES IN RIVER LOCK, AND 4 TURBINES BETWEEN LOCKS.
4 or 5 HYDROPOWER TURBINES
SCALE IN
0 50 100
DEPARTMENT OF
LOCK
HYDROPOWER
SUBMITTED BY:
APPROVED:
REMOVE GUIDE WALL IF TURBINES ARE PLACED BETWEEN LOCKS
EXTEND RIP RAP IF TURBINES ARE PLACED BETWEEN LOCKS
SAFETY PAYS
PG 48





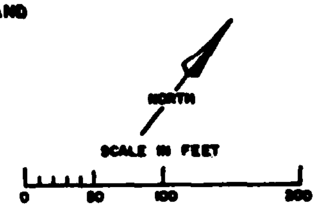
ALTERNATIVE 1 — 4 TURBINES IN SPILLWAY DAM

ALTERNATIVE 2 — 5 TURBINES IN SPILLWAY DAM

ALTERNATIVE 3 — 4 TURBINES IN SPILLWAY DAM AND 4 TURBINES IN RIVER LOCK.

ALTERNATIVE 4 — 5 TURBINES IN SPILLWAY DAM AND 5 TURBINES IN RIVER LOCK.

ALTERNATIVE 5 — 4 TURBINES IN SPILLWAY DAM, 4 TURBINES IN RIVER LOCK, AND 4 TURBINES BETWEEN LOCKS.



SAFETY PAYS

PG 48

DEPARTMENT OF THE ARMY

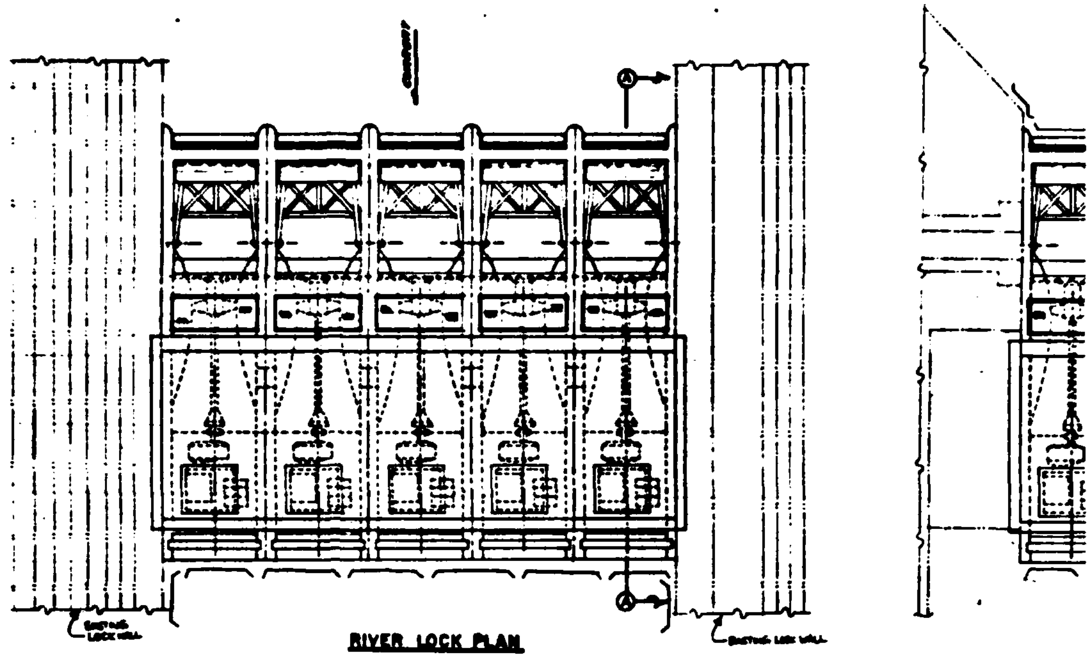
T.M.
M.R.Z
L.B.
SUBMITTED BY:
APPROVED:

MISSISSIPPI RIVER-
LOCK & DAM NO. 2
SITE PLAN
HYDROPOWER RECONNAISSANCE STUDY

DATE: MAY 1981

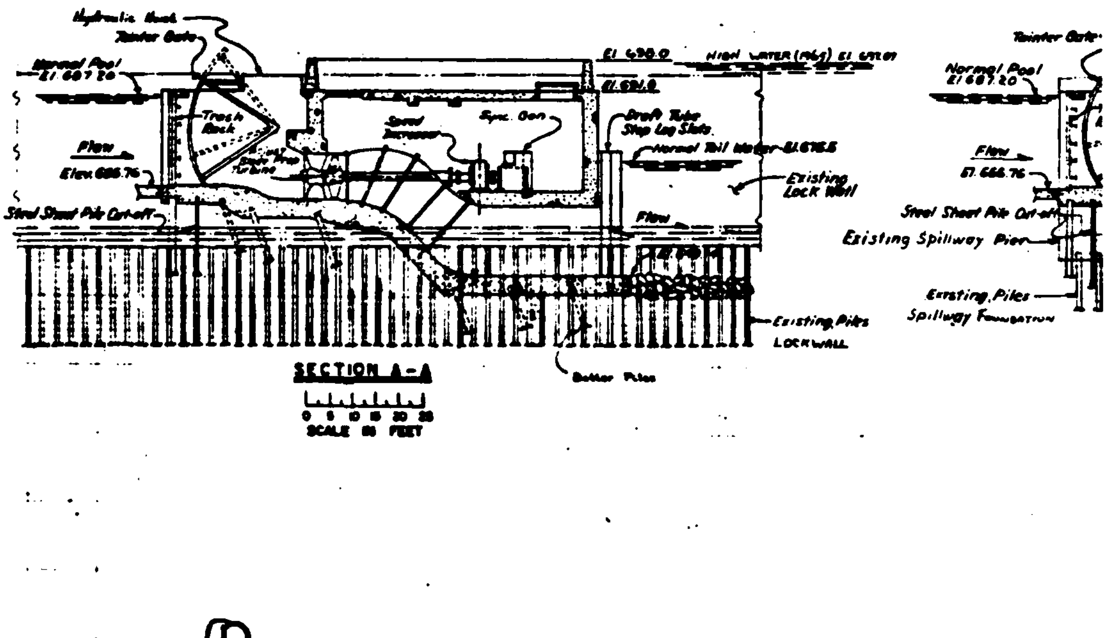
AS SHOWN

PLATE I



RIVER LOCK PLAN

0 5 10 15 20 25
SCALE IN FEET

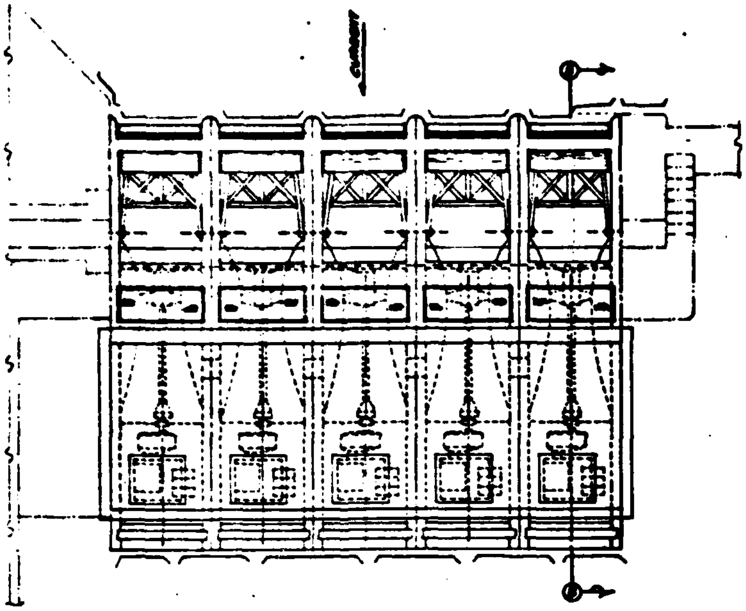


SECTION A-A

0 5 10 15 20 25
SCALE IN FEET

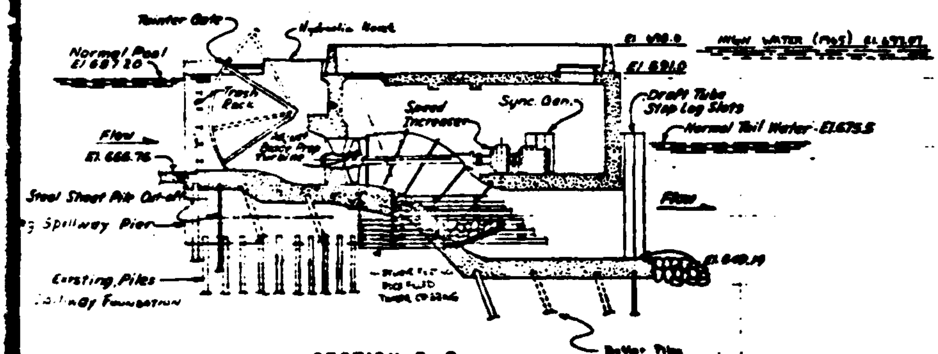
(1)

P649



SPILLWAY DAM PLAN

0 5 10 15 20 25 30
SCALE IN FEET



SECTION B-B

0 5 10 15 20 25
SCALE IN FEET

NOTE: PLAN AND CROSS SECTION FOR INSTALLATION BETWEEN LOCKS IS IDENTICAL TO RIVER LOCK.

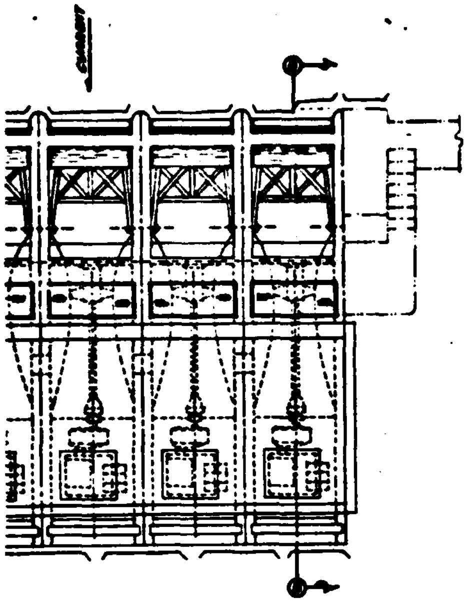
②

③

SPL	LOCK
JCA	POWERHOUSE
SPL	HYDROPOWER
SUBMITTED BY:	
APPROVED:	

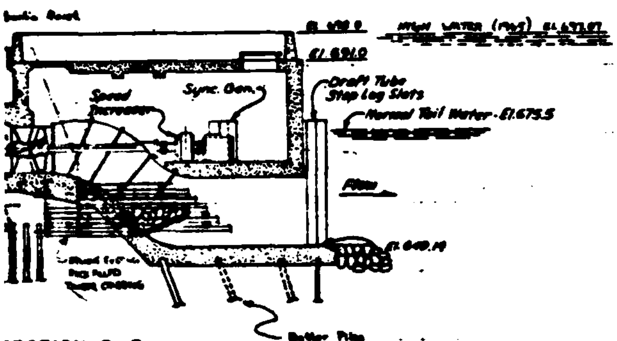
SAFETY PAYS

PG 49



WAY DAM PLAN

0 5 10 15 20 25 30
SCALE IN FEET



SECTION B-B

0 5 10 15 20 25
SCALE IN FEET

NOTE: PLAN AND CROSS SECTION FOR INSTALLATION BETWEEN LOCKS IS IDENTICAL TO RIVER LOCK.

3

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

S P L
J C A
S P L
SUBMITTED BY:
APPROVED:

MISSISSIPPI RIVER
LOCK & DAM NO. 2
POWERHOUSE PLANS AND SECTIONS
HYDROPOWER RECONNAISSANCE STUDY

DATE:
MAY 1981

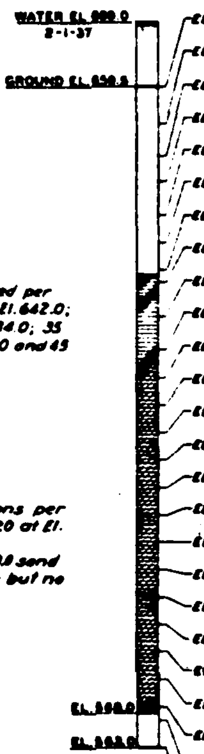
SCALE: AS SHOWN
DRAWING NUMBER

SAFETY PAYS

PG 49

PLATE 2

57



EL.658.5 SAMPLE NO. 57-1 COARSE SAND
Some silt
EL.654.1 SAMPLE NO.57-2 MEDIUM & COARSE SAND
Trace gravel and fine sand.
EL.649.3 SAMPLE NO.57-3 MEDIUM SAND
A little fine sand - trace coarse sand.
EL.645.8 SAMPLE NO.57-4 MEDIUM SAND - a little fine sand - trace coarse sand
*Sand - fine 17.0%, medium 78.0%, coarse 5.0%.
EL.640.8 SAMPLE NO.57-5 MEDIUM SAND
Some fine sand - trace silt and coarse sand.
EL.636.8 SAMPLE NO.57-6 MEDIUM SAND
A little fine sand and trace coarse sand.
EL.632.8 SAMPLE NO.57-7 MEDIUM SAND
Some fine sand - trace silt and coarse sand.
EL.631.0 SAMPLE NO.57-8 SILT
Some fine sand - trace clay.
EL.626.0 SAMPLE NO.57-9 SILT
Some clay - trace fine sand.
EL.621.0 SAMPLE NO.57-10 SILT
Some clay - trace fine sand.
EL.617.0 SAMPLE NO.57-11 CLAY AND SILT
Trace fine sand.
EL.613.0 SAMPLE NO.57-12 CLAY AND SILT
Trace fine sand.
EL.609.0 SAMPLE NO.57-13 CLAY AND SILT
Trace fine sand.
EL.605.0 SAMPLE NO.57-14 CLAY AND SILT
Trace fine sand.
EL.601.0 SAMPLE NO.57-15 CLAY AND SILT
Trace fine sand.
EL.597.0 SAMPLE NO.57-16 CLAY AND SILT
Trace fine sand.
EL.593.0 SAMPLE NO.57-17 CLAY AND SILT
Trace fine sand.
EL.589.0 SAMPLE NO.57-18 CLAY AND SILT
Trace fine sand.
EL.585.0 SAMPLE NO.57-19 CLAY AND SILT
Trace fine sand.
EL.581.0 SAMPLE NO.57-20 CLAY AND SILT
Trace fine sand.
EL.577.0 SAMPLE NO.57-21 CLAY AND SILT
Trace fine sand.
EL.573.0 SAMPLE NO.57-22 CLAY AND SILT
Trace fine sand.
EL.569.0 SAMPLE NO.57-23 CLAY AND SILT
Trace fine sand.
EL.567.0 SAMPLE NO.57-24 MEDIUM & COARSE SAND - trace gravel and fine sand
*Sand - fine 3.0%, medium 59.0%, coarse 37.0%, gravel 1.0%.
EL.563.0 SAMPLE NO.57-25 MEDIUM & COARSE SAND
Trace gravel and fine sand.

Hammer - 255 Lbs.
Drop - 24"
Hammer blows required per foot: 18 at El.648.0; 13 at El.642.0; 30 at El.639.0; 36 at El.634.0; 35 at El.574.0; 44 at El.570.0 and 45 at El.567.0.

Permeability:-
Seepage- In gallons per minute: 15 at El.653.0; 20 at El. 636.0 and 0 at El.632.0.
Artesian flow - At El.563.0 sand heaved 26 feet in casing but no flow was noted.

Prospect drill
2" Casing

Hammer - 255 L
Drop - 14"
hammer blows req
El.655.0 22 at El.652.
at El.644.0, 34 at El.6
42 at El.631.0, 46 at E
62 at El.569.0; 168 at
563.0; 104 at El.558.0 an

Permeability:-
Seepage- In ga
0 at El.638.0; 0 at El.
0 at El.570.0; 12 at El.5
25 at El.558.0 and 0
Artesian flow -
heaved 18 feet in c

Prob
2" Ca

M.

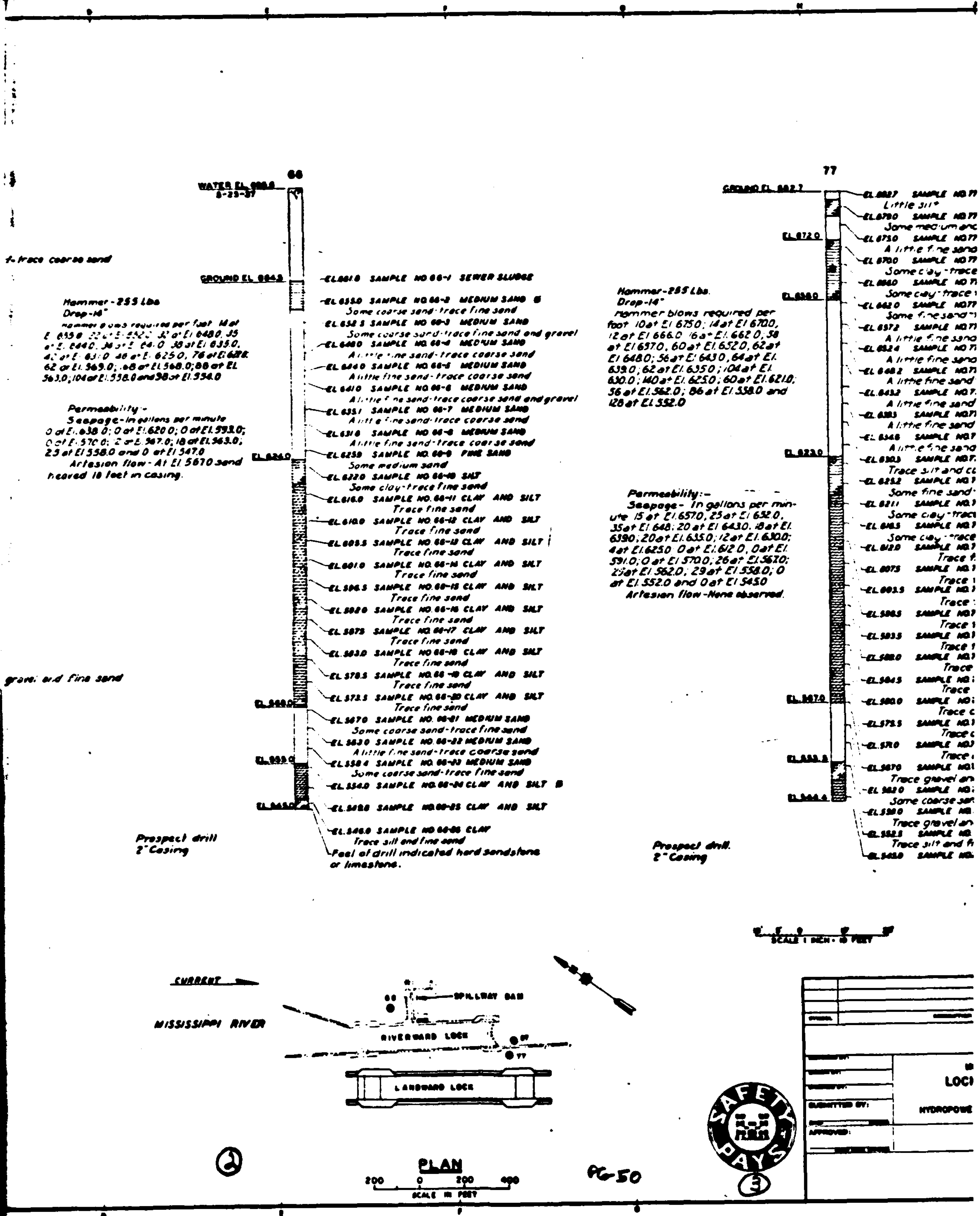
PARTICLE SIZE-MM

CLAY-LESS THAN [illegible]	FINE SILT [illegible]	MEDIUM SILT [illegible]	COARSE SILT [illegible]
FINE SAND [illegible]	MEDIUM SAND [illegible]	COARSE SAND [illegible]	GRAVEL [illegible] UP

General notes:-
* Denotes wash sample

(1)

PG 50



66
WATER EL. 698.0
8-25-37
GROUND EL. 684.5
-EL.681.0 SAMPLE NO.66-1 SEWER SLUDGE
-EL.655.0 SAMPLE NO.66-2 MEDIUM SAND
Some coarse sand - trace fine sand
-EL.652.5 SAMPLE NO.66-3 MEDIUM SAND
Some coarse sand - trace fine sand and gravel
-EL.648.0 SAMPLE NO.66-4 MEDIUM SAND
A little fine sand - trace coarse sand
-EL.644.0 SAMPLE NO.66-5 MEDIUM SAND
A little fine sand - trace coarse sand
-EL.641.0 SAMPLE NO.66-6 MEDIUM SAND
A little fine sand - trace coarse sand and gravel
-EL.635.1 SAMPLE NO.66-7 MEDIUM SAND
A little fine sand - trace coarse sand
-EL.631.8 SAMPLE NO.66-8 MEDIUM SAND
A little fine sand - trace coarse sand
-EL.625.0 SAMPLE NO.66-9 FINE SAND
Some medium sand
-EL.622.0 SAMPLE NO.66-10 SILT
Some clay - trace fine sand
-EL.616.0 SAMPLE NO.66-11 CLAY AND SILT
Trace fine sand
-EL.610.0 SAMPLE NO.66-12 CLAY AND SILT
Trace fine sand
-EL.605.5 SAMPLE NO.66-13 CLAY AND SILT
Trace fine sand
-EL.601.0 SAMPLE NO.66-14 CLAY AND SILT
Trace fine sand
-EL.596.5 SAMPLE NO.66-15 CLAY AND SILT
Trace fine sand
-EL.592.0 SAMPLE NO.66-16 CLAY AND SILT
Trace fine sand
-EL.587.5 SAMPLE NO.66-17 CLAY AND SILT
Trace fine sand
-EL.583.0 SAMPLE NO.66-18 CLAY AND SILT
Trace fine sand
-EL.578.5 SAMPLE NO.66-19 CLAY AND SILT
Trace fine sand
-EL.573.5 SAMPLE NO.66-20 CLAY AND SILT
Trace fine sand
-EL.567.0 SAMPLE NO.66-21 MEDIUM SAND
Some coarse sand - trace fine sand
-EL.563.0 SAMPLE NO.66-22 MEDIUM SAND
A little fine sand - trace coarse sand
-EL.558.4 SAMPLE NO.66-23 MEDIUM SAND
Some coarse sand - trace fine sand
-EL.554.0 SAMPLE NO.66-24 CLAY AND SILT
-EL.548.8 SAMPLE NO.66-25 CLAY AND SILT
-EL.546.0 SAMPLE NO.66-26 CLAY
Trace silt and fine sand
Feel of drill indicated hard sandstone or limestone.
EL.624.0
EL.568.0
EL.559.0
EL.545.0
t - trace coarse sand
gravel and fine sand
Hammer - 255 Lbs.
Drop - 14"
Hammer blows required per foot
Permeability: -
Seepage - in gallons per minute 0 at El.638.0; 0 at El.620.0; 0 at El.593.0; 0 at El.570.0; 2 at El.567.0; 18 at El.563.0; 25 at El.558.0 and 0 at El.547.0
Artesian flow - At El.567.0 sand heaved 18 feet in casing.
Prospect drill
2" Casing
77
GROUND EL. 682.7
EL.672.0
EL.658.0
EL.623.0
EL.567.0
EL.553.5
EL.544.4
Little silt
Some medium and
A little fine sand
Some clay - trace
Some fine sand
A little fine sand
Trace silt and cl
Trace gravel an
Some coarse san
Trace silt and fi
Hammer - 255 Lbs.
Drop - 14"
Hammer blows required per foot 10 at El.675.0; 14 at El.670.0, 12 at El.666.0; 16 at El.662.0; 58 at El.657.0, 60 at El.652.0, 62 at El.648.0; 56 at El.643.0, 64 at El.639.0; 62 at El.635.0; 104 at El.630.0; 140 at El.625.0; 60 at El.621.0; 56 at El.562.0; 86 at El.558.0 and 128 at El.552.0
Permeability: -
Seepage - In gallons per minute 15 at El.657.0, 25 at El.652.0, 35 at El.648; 20 at El.643.0; 18 at El.639.0; 20 at El.635.0; 12 at El.630.0; 4 at El.625.0 0 at El.612.0, 0 at El.591.0; 0 at El.570.0; 26 at El.567.0; 27 at El.562.0; 29 at El.558.0; 0 at El.552.0 and 0 at El.545.0
Artesian flow - None observed.
Prospect drill.
2" Casing
SCALE 1 INCH = 10 FEET
CURRENT
MISSISSIPPI RIVER
SPILLWAY DAM
RIVERWARD LOCK
LANDWARD LOCK
PLAN
200 0 200 400
SCALE IN FEET
SUBMITTED BY:
APPROVED:
LOC
HYDROPOWE
SAFETY PAYS
PG-50

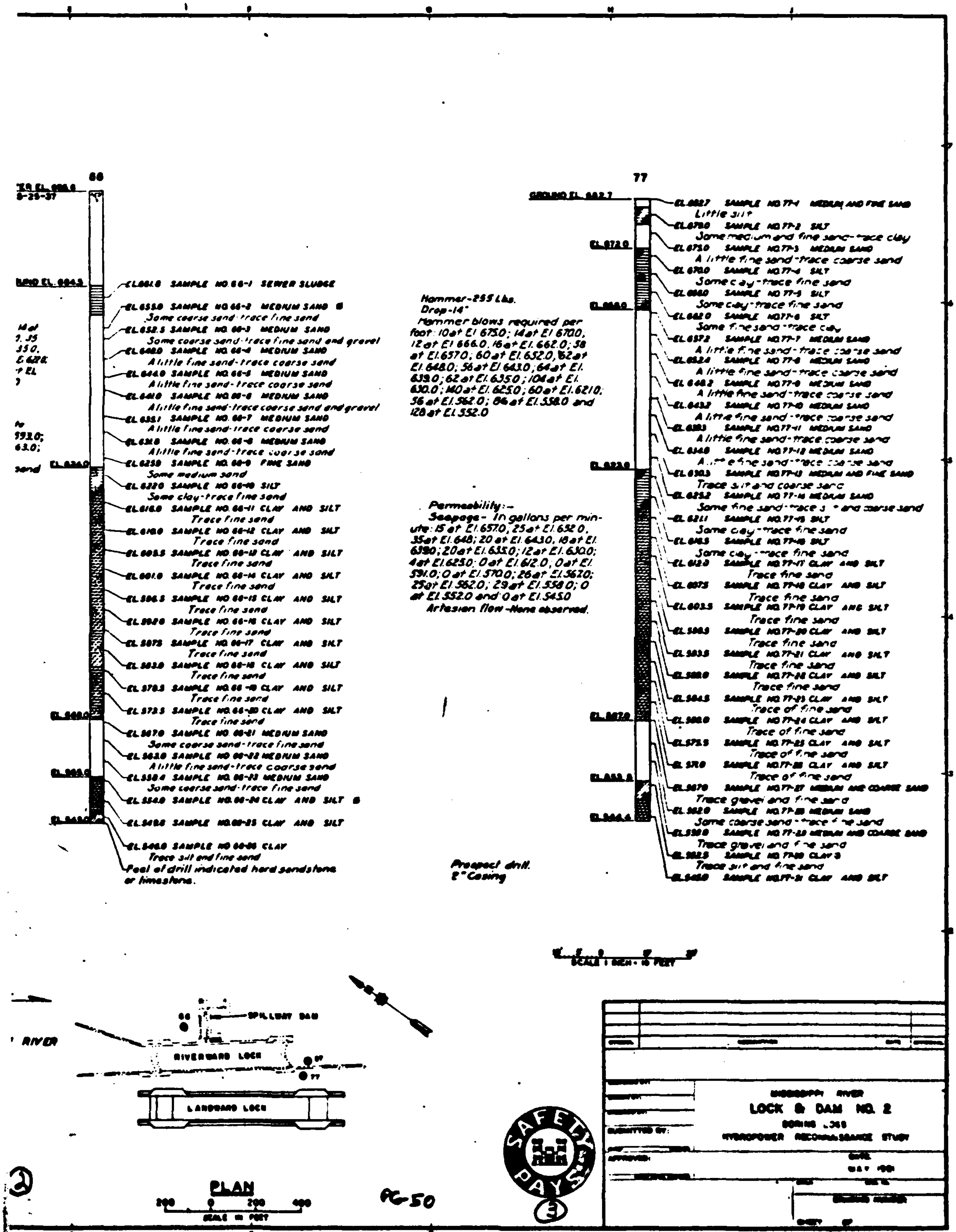

66
8-25-37
EL. 661.0 SAMPLE NO. 66-1 SEWER SLUDGE
EL. 655.0 SAMPLE NO. 66-2 MEDIUM SAND
Some coarse sand - trace fine sand
EL. 652.5 SAMPLE NO. 66-3 MEDIUM SAND
Some coarse sand - trace fine sand and gravel
EL. 648.0 SAMPLE NO. 66-4 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 644.0 SAMPLE NO. 66-5 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 641.0 SAMPLE NO. 66-6 MEDIUM SAND
A little fine sand - trace coarse sand and gravel
EL. 635.1 SAMPLE NO. 66-7 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 632.0 SAMPLE NO. 66-8 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 625.0 SAMPLE NO. 66-9 FINE SAND
Some medium sand
EL. 622.0 SAMPLE NO. 66-10 SILT
Some clay - trace fine sand
EL. 616.0 SAMPLE NO. 66-11 CLAY AND SILT
Trace fine sand
EL. 610.0 SAMPLE NO. 66-12 CLAY AND SILT
Trace fine sand
EL. 605.5 SAMPLE NO. 66-13 CLAY AND SILT
Trace fine sand
EL. 601.0 SAMPLE NO. 66-14 CLAY AND SILT
Trace fine sand
EL. 596.5 SAMPLE NO. 66-15 CLAY AND SILT
Trace fine sand
EL. 592.0 SAMPLE NO. 66-16 CLAY AND SILT
Trace fine sand
EL. 587.5 SAMPLE NO. 66-17 CLAY AND SILT
Trace fine sand
EL. 583.0 SAMPLE NO. 66-18 CLAY AND SILT
Trace fine sand
EL. 578.5 SAMPLE NO. 66-19 CLAY AND SILT
Trace fine sand
EL. 572.5 SAMPLE NO. 66-20 CLAY AND SILT
Trace fine sand
EL. 567.0 SAMPLE NO. 66-21 MEDIUM SAND
Some coarse sand - trace fine sand
EL. 562.0 SAMPLE NO. 66-22 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 558.4 SAMPLE NO. 66-23 MEDIUM SAND
Some coarse sand - trace fine sand
EL. 554.0 SAMPLE NO. 66-24 CLAY AND SILT
EL. 549.6 SAMPLE NO. 66-25 CLAY AND SILT
EL. 546.0 SAMPLE NO. 66-26 CLAY
Trace silt and fine sand
Feel of drill indicated hard sandstone or limestone.
Hammer - 255 Lbs.
Drop - 14"
Hammer blows required per foot: 10 at El. 675.0; 14 at El. 670.0; 12 at El. 666.0, 16 at El. 662.0; 38 at El. 657.0; 60 at El. 652.0, 62 at El. 648.0; 56 at El. 643.0; 64 at El. 639.0; 62 at El. 635.0; 104 at El. 630.0; 140 at El. 625.0; 60 at El. 621.0; 56 at El. 562.0; 86 at El. 558.0 and 128 at El. 552.0
Permeability:-
Seepage - In gallons per minute: 15 at El. 657.0, 25 at El. 652.0, 35 at El. 648; 20 at El. 643.0, 18 at El. 639.0; 20 at El. 635.0; 12 at El. 630.0; 4 at El. 625.0; 0 at El. 612.0; 0 at El. 591.0; 0 at El. 570.0; 26 at El. 567.0; 25 at El. 562.0; 29 at El. 558.0; 0 at El. 552.0 and 0 at El. 545.0
Artesian flow - None observed.
Prospect drill.
2" Casing
77
GROUND EL. 682.7
EL. 682.7 SAMPLE NO. 77-1 MEDIUM AND FINE SAND
Little silt
EL. 678.0 SAMPLE NO. 77-2 SILT
Some medium and fine sand - trace clay
EL. 675.0 SAMPLE NO. 77-3 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 670.0 SAMPLE NO. 77-4 SILT
Some clay - trace fine sand
EL. 666.0 SAMPLE NO. 77-5 SILT
Some clay - trace fine sand
EL. 662.0 SAMPLE NO. 77-6 SILT
Some fine sand - trace clay
EL. 657.2 SAMPLE NO. 77-7 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 652.4 SAMPLE NO. 77-8 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 648.2 SAMPLE NO. 77-9 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 643.2 SAMPLE NO. 77-10 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 638.3 SAMPLE NO. 77-11 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 634.0 SAMPLE NO. 77-12 MEDIUM SAND
A little fine sand - trace coarse sand
EL. 630.5 SAMPLE NO. 77-13 MEDIUM AND FINE SAND
Trace silt and coarse sand
EL. 625.2 SAMPLE NO. 77-14 MEDIUM SAND
Some fine sand - trace silt and coarse sand
EL. 621.1 SAMPLE NO. 77-15 SILT
Some clay - trace fine sand
EL. 616.5 SAMPLE NO. 77-16 SILT
Some clay - trace fine sand
EL. 612.0 SAMPLE NO. 77-17 CLAY AND SILT
Trace fine sand
EL. 607.5 SAMPLE NO. 77-18 CLAY AND SILT
Trace fine sand
EL. 603.5 SAMPLE NO. 77-19 CLAY AND SILT
Trace fine sand
EL. 598.5 SAMPLE NO. 77-20 CLAY AND SILT
Trace fine sand
EL. 593.5 SAMPLE NO. 77-21 CLAY AND SILT
Trace fine sand
EL. 589.0 SAMPLE NO. 77-22 CLAY AND SILT
Trace fine sand
EL. 584.5 SAMPLE NO. 77-23 CLAY AND SILT
Trace of fine sand
EL. 580.0 SAMPLE NO. 77-24 CLAY AND SILT
Trace of fine sand
EL. 575.5 SAMPLE NO. 77-25 CLAY AND SILT
Trace of fine sand
EL. 571.0 SAMPLE NO. 77-26 CLAY AND SILT
Trace of fine sand
EL. 567.0 SAMPLE NO. 77-27 MEDIUM AND COARSE SAND
Trace gravel and fine sand
EL. 562.0 SAMPLE NO. 77-28 MEDIUM SAND
Some coarse sand - trace fine sand
EL. 558.0 SAMPLE NO. 77-29 MEDIUM AND COARSE SAND
Trace gravel and fine sand
EL. 552.5 SAMPLE NO. 77-30 CLAY
Trace silt and fine sand
EL. 545.0 SAMPLE NO. 77-31 CLAY AND SILT
SCALE 1 INCH = 10 FEET
RIVER
SPILLWAY DAM
RIVERWARD LOCK
LANDWARD LOCK
PLAN
200 0 200 400
SCALE IN FEET
PG-50
SAFETY PAYS
SUBMITTED BY:
APPROVED:
MISSISSIPPI RIVER
LOCK & DAM NO. 2
BORING LOGS
HYDROPOWER RECONNAISSANCE STUDY
DATE
MAY 1981
DRAWING NUMBER
SHEET OF

PLATE 3

APPENDIX A

CONSTRUCTION COST ESTIMATE

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TABLES

APPENDIX A

CONSTRUCTION COST ESTIMATE

BASIS FOR COST ESTIMATES

Estimated costs in this appendix are generally based on unit prices adjusted to reflect average bid prices received by the St. Paul District on comparable work. Costs for electromechanical machinery are an exception. These costs are based on a 9 October 1980 quote from Allis Chalmers. An allowance of 15 percent for contingencies is included in the estimated costs.

FIRST COSTS

The detailed estimate of first costs for the alternatives evaluated in this report is given in tables A-1 through A-5. The costs shown are based on October 1980 price levels. No costs for lands are included because the site considered is federally owned.

Table A-1 - Detailed estimate of first costs - alternative 1 (four units in spillway dam)

Description	Estimated quantity	Unit	Unit price	Estimated amount
Tube turbines	-	LS	-	$4,588,000
Powerhouse civil costs	-	LS	-	1,320,000
Station electrical equipment	-	LS	-	301,600
Miscellaneous power plant equipment	-	LS	-	178,600
Switchyard civil costs	-	LS	-	17,400
Switchyard equipment costs	-	LS	-	113,700
Transmission line costs	-	LS	-	63,300
Equipment costs for multiple units	-	LS	-	225,000
Site specific				
Upstream cofferdam	6,300		$4.00	25,200
Downstream cofferdam	9,085		4.00	36,340
Dewatering	-	LS	-	115,200
Excavation	14,100	CY	5.00	70,500
Sheet pile	31,250	SF	18.00	562,500
Riprap	12,790	CY	25.00	319,750
Bedding (type 1)	3,654	CY	15.00	54,810
Structural removals	-	LS	-	101,200
Fill	1,500	CY	4.00	6,000
Subtotal				8,099,100
Contingencies (15 percent)				1,214,865
Subtotal				9,313,965
Engineering and design (3 percent)				279,419
Supervision and administration (3 percent)				279,419
Project cost (alternative 1)				9,872,800
			Use	9,870,000

Table A-2 - Detailed estimate of first costs - alternative 2 (five units in spillway dam)

Description	Estimated quantity	Unit	Unit price	Estimated amount
Tube turbines	-	LS	-	$5,735,000
Powerhouse civil costs	-	LS	-	1,649,000
Station electrical equipment	-	LS	-	359,600
Miscellaneous power plant equipment	-	LS	-	197,200
Switchyard civil costs	-	LS	-	20,900
Switchyard equipment costs	-	LS	-	127,600
Transmission line cost	-	LS	-	67,900
Equipment costs for multiple units	-	LS	-	292,000
Site specific				
Upstream cofferdam	6,300	CY	$4.00	25,200
Downstream cofferdam	9,085	CY	4.00	36,340
Dewatering	-	LS	-	134,400
Excavation	14,100	CY	5.00	70,500
Sheet pile	31,250	SF	18.00	562,500
Riprap	15,072	CY	25.00	376,800
Bedding (type 1)	4,306	CY	15.00	64,590
Structural removals	-	LS	-	127,500
Fill	1,800	CY	4.00	7,200
Subtotal				9,854,230
Contingencies (15 percent)				1,478,134
Subtotal				11,332,364
Engineering and design (3 percent)				339,971
Supervision and administration (3 percent)				339,971
Project cost (alternative 2)				12,012,306
			Use	12,010,000

Table A-3 - Detailed estimate of first costs - alternative 3 (four units in spillway dam and four units in river lock)

Description	Estimated quantity	Unit	Unit price	Estimated amount
Tube turbines	-	LS	-	$9,176,000
Powerhouse civil costs	-	LS	-	2,640,000
Station electrical equipment	-	LS		475,600
Miscellaneous power plant equipment	-	LS	-	236,600
Switchyard civil costs	-	LS	-	27,800
Switchyard equipment costs	-	LS	-	158,900
Transmission line costs	-	LS	-	81,400
Equipment cost for multiple units	-	LS	-	494,000
Site specific				
Upstream cofferdam	6,300	CY	$4.00	25,200
Downstream cofferdam	14,215	CY	4.00	56,860
Dewatering	-	LS	-	201,600
Excavation	39,300	CY	5.00	196,500
Sheet pile	53,250	SF	18.00	958,500
Riprap	22,235	CY	25.00	555,875
Bedding (type 1)	6,353	CY	15.00	95,445
Structural removals	-	LS	-	325,800
Fill	2,200	CY	4.00	8,800
Install A-frames	-	LS	-	18,000
Subtotal				15,732,880
Contingencies (15 percent)				2,359,932
Subtotal				18,092,812
Engineering and design (3 percent)				542,784
Supervision and administration (3 percent)				542,784
Project cost (alternative 3)				19,178,380
			Use	19,180,000

Table A-4 - Detailed estimate of first costs - alternative 4 (five units in spillway dam and five units in river lock)

Description	Estimated quantity	Unit	Unit price	Estimated amount
Tube turbines	-	LS	-	$11,470,000
Powerhouse civil costs	-	LS	-	3,298,000
Station electrical equipment	-	LS	-	556,800
Miscellaneous power plant equipment	-	LS	-	255,200
Switchyard civil costs	-	LS	-	33,600
Switchyard equipment costs	-	LS	-	174,000
Transmission line costs	-	LS	-	90,500
Equipment costs for multiple units	-	LS	-	628,000
Site specific				
Upstream cofferdam	6,300	CY	$4.00	25,200
Downstream cofferdam	14,215	CY	4.00	56,860
Dewatering	-	LS	-	201,600
Excavation	43,100	CY	5.00	215,500
Sheet pile	53,250	SF	18.00	958,500
Riprap	24,973	CY	25.00	624,325
Bedding (type 1)	7,135	CY	15.00	107,025
Structural removals	-	LS	-	352,000
Fill	1,800	CY	4.00	7,200
Install A-frames	-	LS	-	18,000
Subtotal				19,072,310
Contingencies (15 percent)				2,860,846
Subtotal				21,933,156
Engineering and design (3 percent)				657,995
Supervision and administration (3 percent)				657,995
Project cost (alternative 4)				23,249,146
			Use	23,250,000

Table A-5 - Detailed estimate of first costs - alternative 5 (four units in spillway dam, four units in river lock, and four units between locks)

Description	Estimated quantity	Unit	Unit price	Estimated amount
Tube turbines	-	LS	-	$13,764,000
Powerhouse civil costs	-	LS	-	3,960,000
Station electrical equipment	-	LS	-	614,800
Miscellaneous power plant equipment	-	LS	-	278,400
Switchyard civil costs	-	LS	-	39,400
Switchyard equipment costs	-	LS	-	191,400
Transmission line costs	-	LS	-	98,000
Equipment costs for multiple units	-	LS	-	763,000
Site specific				
Upstream cofferdams	6,300	CY	$4.00	25,200
Downstream cofferdams	14,215	CY	4.00	56,860
Dewatering	-	LS	-	259,200
Excavation	82,300	CY	5.00	411,500
Sheet pile	70,250	SF	18.00	1,264,500
Riprap	39,619	CY	25.00	990,475
Bedding (type 1)	13,602	CY	15.00	204,030
Structural removals	-	LS	-	536,000
Fill	2,200	CY	4.00	8,800
Install A-frames	-	LS	-	18,000
New guide wall	-	LS	-	1,291,200
Subtotal				24,774,765
Contingencies (15 percent)				3,716,215
Subtotal				28,490,980
Engineering and design (3 percent)				854,729
Supervision and administration (3 percent)				854,729
Project cost (alternative 5)				30,200,438
			Use	30,200,000

ESTIMATE OF ANNUAL CHARGES

Annual charges for the proposed alternatives are based on an interest rate of 7 3/8 percent and an amortization period of 100 years. Also included in annual charges is an allowance for interest during an assumed 2-year construction period. Estimates of annual charges for the alternatives are given in tables A-6 through A-10.

Table A-6 - Estimate of annual charges - alternative 1 (four units in spillway dam)

Item	First costs or present value	Annual charges
Construction first cost	$9,870,000	
Present value deferred cost (1)	40,000	
Interest during construction	601,400	
Present value of salvage (2)	-11,500	
Federal investment	10,499,900	
Interest and amortization of Federal investment (x 0.07381) (3)		$775,000
Operation and maintenance		33,000
Total annual charges		808,000

(1) Considers major rehabilitation of operating machinery 50 years hence.
(2) Considers salvageable items after rehabilitation 50 years hence and at the end of project economic life.
(3) Interest and amortization for 100-year life at 7 3/8 percent interest rate.

Table A-7 - Estimate of annual charges - alternative 2 (five units in spillway dam)

Item	First costs or present value	Annual charges
Construction first cost	$12,010,000	
Present value deferred cost[1]	48,500	
Interest during construction	731,800	
Present value of salvage[2]	-14,000	
Federal investment	12,776,300	
Interest and amortization of Federal investment (x 0.07381)[3]		$943,000
Operation and maintenance		43,000
Total annual charges		986,000

(1) Considers major rehabilitation of operating machinery 50 years hence.
(2) Considers salvageable items after rehabilitation 50 years hence and at end of project economic life.
(3) Interest and amortization for 100-year life at 7 3/8 percent interest rate.

Table A-8 - Estimate of annual charges - alternative 3 (four units in spillway dam and four units in river lock)

Item	First costs or present value	Annual charges
Construction first cost	$19,180,000	
Present value deferred cost[1]	73,000	
Interest during construction	1,168,700	
Present value of salvage[2]	-21,000	
Federal investment	20,400,700	
Interest and amortization of Federal investment (x 0.07381)[3]		$1,505,800
Operation and maintenance		67,000
Total annual charges		1,572,800

(1) Considers major rehabilitation of operating machinery 50 years hence.
(2) Considers salvageable items after rehabilitation 50 years hence and at end of project economic life.
(3) Interest and amortization for 100-year life at 7 3/8-percent interest rate.

Table A-9 - Estimate of annual charges - alternative 4 (five units in spillway dam and five units in river lock)

Item	First costs or present value	Annual charges
Construction first cost	$23,250,000	
Present value deferred cost(1)	88,000	
Interest during construction	1,416,700	
Present value of salvage(2)	-26,000	
Federal investment	24,728,700	
Interest and amortization of Federal investment (x 0.07381)(3)		$1,825,200
Operation and maintenance		84,000
Total annual charges		1,909,200

(1) Considers major rehabilitation of operating machinery 50 years hence.
(2) Considers salvageable items after rehabilitation 50 years hence and at end of project economic life.
(3) Interest and amortization for 100-year life at 7 3/8-percent interest rate.

Table A-10 - Estimate of annual charges - alternative 5 (four units in spillway dam, four units in river lock, and four units between locks)

Item	First costs or present value	Annual charges
Construction first cost	$30,250,000	
Present value deferred cost(1)	88,000	
Interest during construction	1,416,700	
Present value of salvage(2)	-26,000	
Federal investment	24,728,700	
Interest and amortization of Federal investment (x 0.07381)(3)		$2,370,200
Operation and maintenance		102,000
Total annual charges		2,472,200

(1) Considers major rehabilitation of operating machinery 50 years hence.
(2) Considers salvageable items after rehabilitation 50 years hence and at end of project economic life.
(3) Interest and amortization for 100-year life at 7 3/8 percent interest rate.

APPENDIX B
COORDINATION

APPENDIX B

COORDINATION

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APPENDIX B

COORDINATION

This appendix presents the views and comments of other Federal agencies and non-Federal interests with reference to considered hydropower development at lock and dam 2. The material inclosed includes letters in response to the 30 January 1981 notice of the lock and dam 2 hydropower reconnaissance study. Also included is other pertinent correspondence related to the study.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB   30 January 1981

NOTICE

LOCKS AND DAM 2 HYDROPOWER RECONNAISSANCE STUDY

The St. Paul District, Corps of Engineers, has initiated a reconnaissance study to determine the potential for hydropower generation at the existing Corps of Engineers navigation locks and dam 2 on the Mississippi River at Hastings, Minnesota. The reconnaissance report culminating the study will be completed by September 1981.

The intent of the reconnaissance study is to establish, in a general way, whether hydropower production at locks and dam 2 is economically justified and assess the issues that may be critical to implementation. Existing information will be used to the extent practicable. The reconnaissance study will not provide detailed formulation of a plan or optimal scale of development. Rather, the study will show whether at least one plan is workable and feasible. If a plan is found justified, a more detailed feasibility study will be recommended to start in fiscal year 1982 which begins 1 October 1981.

Because the reconnaissance study is preliminary, an intensive public involvement program is not planned. Agencies and interests are being informed of the study at its outset and invited to participate by this mailed notice. News releases to the general public will be prepared, as appropriate. When the reconnaissance study is completed, a public meeting will be held to discuss the report and its findings and help direct feasibility study efforts, if further studies are recommended in the reconnaissance report.

At this time, we request your input and suggestions regarding the study. Your comments can be sent to:

District Engineer
St. Paul District, Corps of Engineers
ATTN: Planning Branch
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

William W. Badger

WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer

ALLIS-CHALMERS
BOX 712 • YORK, PENNSYLVANIA 17405 / 717 792-3511

YORK PLANT
HYDRO-TURBINE DIVISION

October 9, 1980

Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

ATTENTION: Mr. Louis E. Kowalski
Chief Planning Branch
Engineering Division

SUBJECT: Hastings, MN Lock & Dam
2 A-C Inquiry 6-33748

Dear Mr. Kowalski:

Per your request dated September 8, 1980 we have enclosed preliminary technical data and prices for the hydraulic generating equipment per your request.

Briefly describing the equipment, we propose horizontal adjustable blade standardized TUBE turbine generating units with sizes and ratings as outlined in Table 1, which is attached. Included in our supply would be the following:

1) Hydraulically operated fixed wheel intake gate (butterfly valve available as option)
2) Adjustable blade (3 blades) hydraulic TUBE turbine
3) Speed increaser with low speed input shaft directly connected to the turbine shaft and high speed directly connected to the generator
4) Synchronous type generators with ratings as outlined in Table 1 and rated full operation at 3 phase, 60 hertz, 2400/4160 volts with a 0.9 power factor and price including brushless excitation, voltage regulator, lightning arrestor, grounding resistor and surge capacitor
5) Blade positioner for control of adjustable blades
6) Oil pressure system for the oil supply to the blade positioner and fixed wheel intake gate
7) Electrical monitoring and control panel
8) Outdoor high voltage module, outdoor cubicle for utility metering system, high voltage switch, fuse and substation transformers

Our present day preliminary prices on Table 1 are per unit's in U.S. dollars and include the design and manufacture of the standardized hydroelectric units as described above with prices F.O.B. factory.

The overall dimensions for the proposed equipment can be obtained from page 6 of the Standardized Hydroelectric Generating Unit brochure 54B10241-03, which is enclosed.

We are presently anticipating twelve (12) months delivery on the first unit from date of award, with each additional unit in one (1) month increments for the equipment as described above.

Expected performance curves for the turbines are as referred to in Table 1.

The preliminary sizes and prices quoted for standardized hydroelectric generating units are based on the available site information. Should your analysis indicate that this power generation project is not feasible, we offer our services to review your data. We will provide comments and recommendations.

If further information is desired concerning this equipment or any other inquiry, please do not hestitate to call upon us.

Very truly yours,

G. M. Hickey, P. E.
Sales Engineer
Standard Products

GMH/ksb

Enclosures

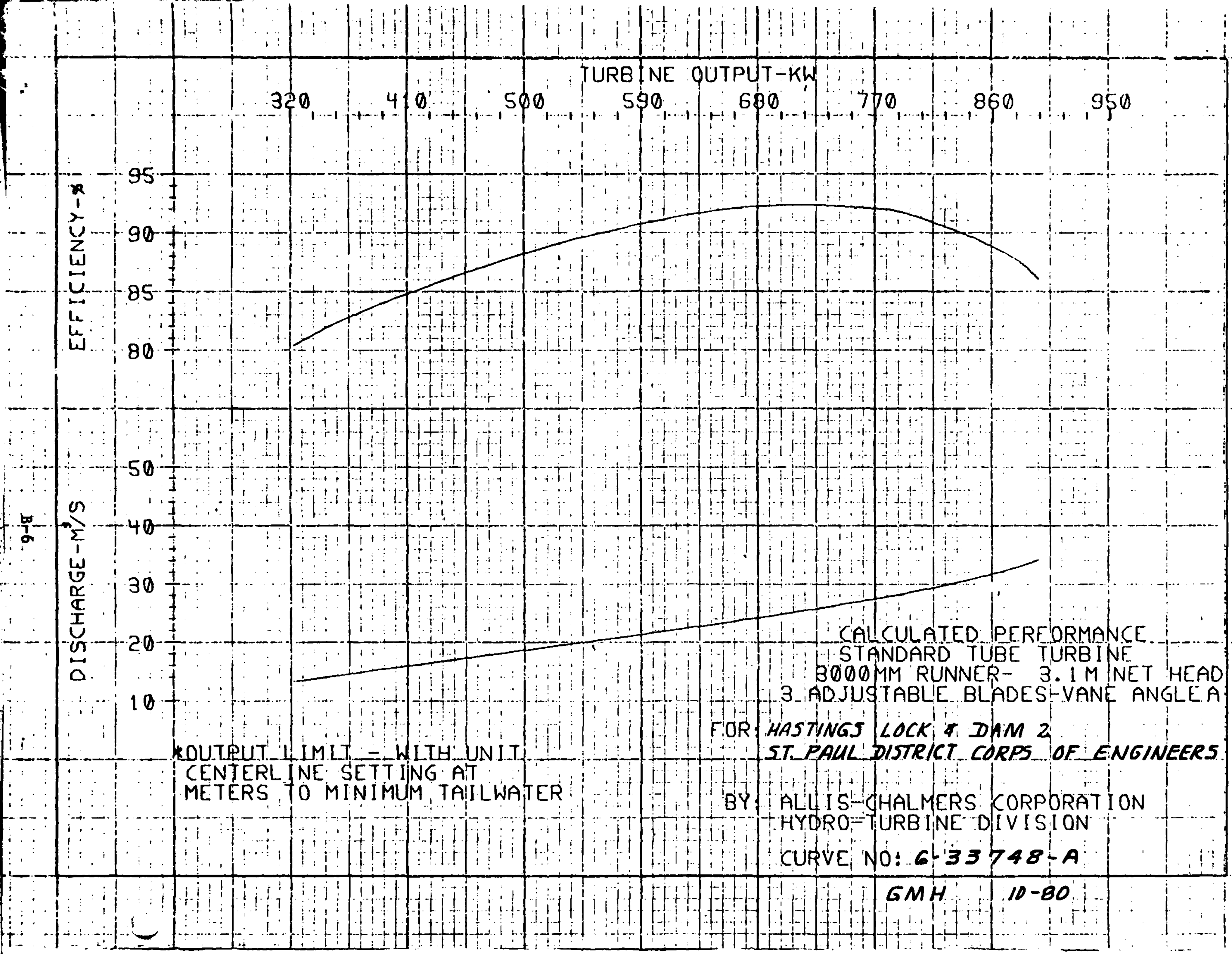
cc: Mr. Gordon Heitzman
Mr. Al Bjorkquist
W. Ford

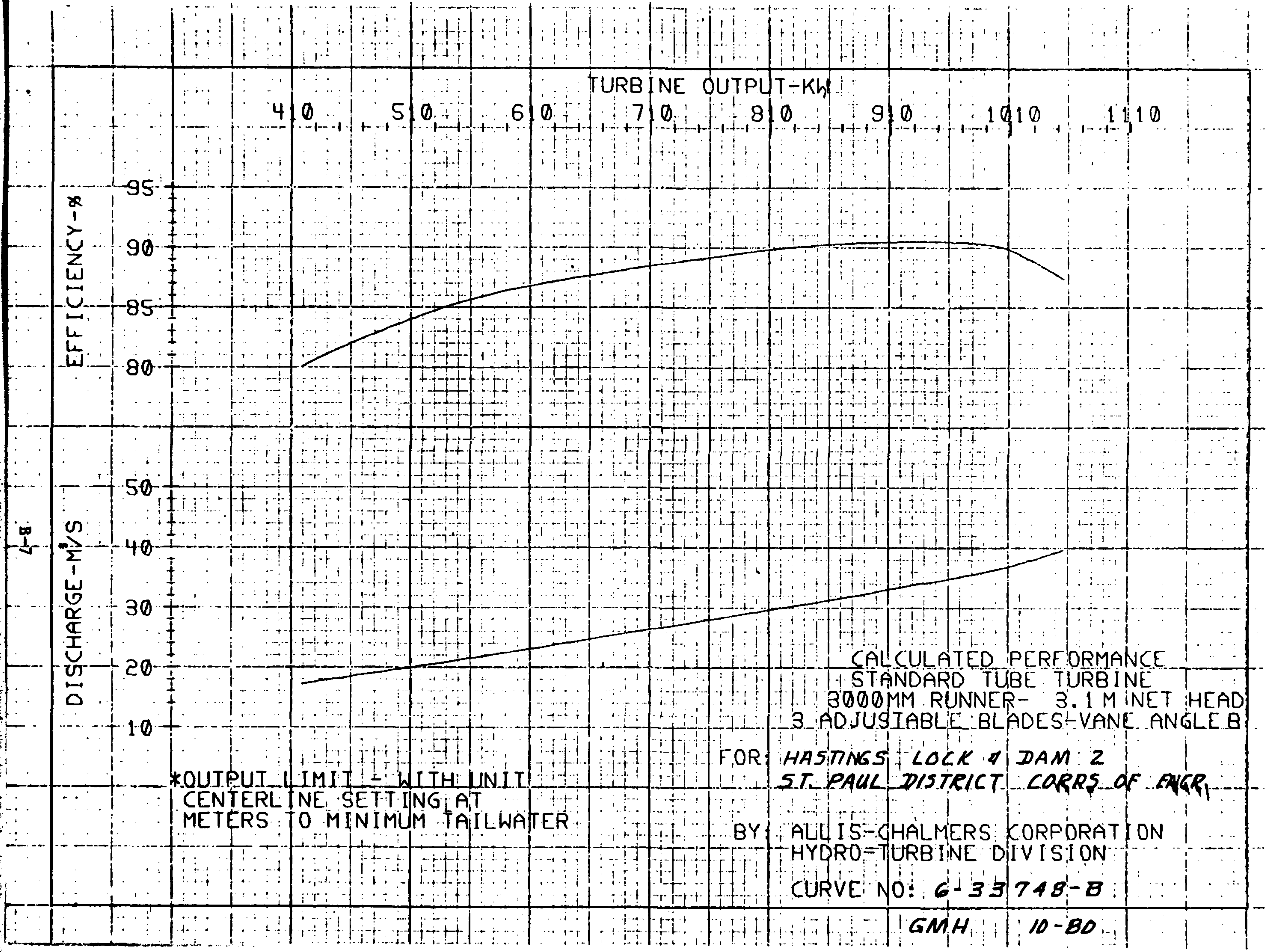
TABLE 1

FEASIBILITY STUDY
FOR
ST. PAUL DISTRICT, CORPS OF ENGINEERS
HASTINGS, MN LOCK & DAM 2
A-C INQUIRY 6-33748

ALTERNATE	A	B
Turbine Runner Size (mm)	3000	3000
No. of Adjustable Blades	3	3
Maximum Turbine Rating (kW)	900	1055
Maximum Rated Flow (*cms*)	34.16	39.7
Rated Net Head (m)	3.0	3.0
Unit Centerline Setting as ....(m) Above Minimum Tailwater	0.0	0.0
Expected Performance Curve No.	6-33748-A	6-33748-B
Estimated Price ($)/Units	903,000	907,000
Expected Annual Energy (GWH/#Units)	45.3/10	44.1/8
Expected Annual Energy (GWH/#Units)		46.2/9

Allis-Chalmers Corporation
Hydro-Turbine Division
York, Pennsylvania
10/9/80


TURBINE OUTPUT-KW
320
410
500
590
680
770
860
950
EFFICIENCY-%
95
90
85
80
DISCHARGE-M³/S
50
40
30
20
10
*OUTPUT LIMIT - WITH UNIT
CENTERLINE SETTING AT
METERS TO MINIMUM TAILWATER
CALCULATED PERFORMANCE
STANDARD TUBE TURBINE
3000MM RUNNER- 3.1 M NET HEAD
3 ADJUSTABLE BLADES-VANE ANGLE A
FOR: HASTINGS LOCK & DAM 2
ST PAUL DISTRICT CORPS OF ENGINEERS
BY: ALLIS-CHALMERS CORPORATION
HYDRO-TURBINE DIVISION
CURVE NO: 6-33748-A
GMH 10-80


TURBINE OUTPUT-KW
410 510 610 710 810 910 1010 1110
EFFICIENCY-%
95 90 85 80
DISCHARGE-M³/S
50 40 30 20 10
*OUTPUT LIMIT - WITH UNIT
CENTERLINE SETTING AT
METERS TO MINIMUM TAILWATER
CALCULATED PERFORMANCE
STANDARD TUBE TURBINE
3000MM RUNNER- 3.1 M NET HEAD
3 ADJUSTABLE BLADES-VANE ANGLE B
FOR: HASTINGS LOCK 4 DAM 2
ST. PAUL DISTRICT CORPS OF ENGR
BY: ALLIS-CHALMERS CORPORATION
HYDRO-TURBINE DIVISION
CURVE NO: 6-33748-B
GMH 10-80

CITY OF SAINT PAUL
DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

DIVISION OF PLANNING
25 West Fourth Street, Saint Paul, Minnesota, 55102
612-298-4151

GEORGE LATIMER
MAYOR

February 2, 1981

District Engineer
U. S. Army Corps of Engineers,
St. Paul District
1135 U. S. Post Office
St. Paul, Minnesota 55101

Attention: Planning Branch

Please include me on your mailing list for the upcoming Hydropower Reconnaissance Studies for Lower St. Anthony Falls Lock and Dam (LSAF) and Locks and Dam 2.

The studies looking interesting. The City of Saint Paul is anxious to keep informed of their progress and findings.

Thank you.

Sincerely,

Rick Wiederhorn

Richard J. Wiederhorn
Senior Planner

RJW/cc

2/5/81

JEROME TIX
1320 RAMSEY ST
HASTINGS MN 55033

Dear Sir

Read a article in the Hastings Star + Gazette this day, and a letter is in order. the study the corp is making at Lock & Dam 2 in my opinion, as a resident of Hastings, + a lover of the River, it great.

The Hydropower project would be a natural resource and no harm would come to the River, or the environment in + around the River. this Country of our's sure needs to take a good look at our natural resource such as this ~~project~~ project the corp has undertaken. Keep up the good work + spend the tax dollars for projects like this. "I thank you"

Jerome Tix

GEORGE LATIMER
MAYOR

CITY OF SAINT PAUL

OFFICE OF THE MAYOR

347 CITY HALL
SAINT PAUL, MINNESOTA 55102
612 298-4323

Feb. 5, 1981

TO: District Engineer
St. Paul District, Corps. of Engineers

ATTN: Planning Branch
1135 U.S. Post Office and Custom House
St. Paul, MN 55101

RE: NCSED-PB

We've received notice on a reconnaissance study for lock and dam #2 at Hastings and Lower St. Anthony Falls lock and dam between Minneapolis and St. Paul. I agree that we should look to the Mississippi River for hydropower if it does not mean more dam and construction activity without a thorough economic analysis. I fully support your intention to study the possibility of hydropower at these two dam sites. Please keep my Office informed when the preliminary results and findings are available so that we may study them.

Sincerely,

George Latimer

George Latimer, Mayor

United States Department of the Interior

FISH AND WILDLIFE SERVICE

St. Paul Field Office, Ecological Services
538 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

IN REPLY REFER TO:

March 3, 1981

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This responds to your January 30, 1981 notice requesting our comments on the preparation of a reconnaissance study for hydropower generation at lock and dam 2 and St. Anthony Falls on the Mississippi River in Minnesota. We offer the following comments to assist you in the preparation of this study.

Existing Fish and Wildlife Resources

Fish and wildlife populations are somewhat limited in the Minneapolis pools primarily because of the lack of shallow water habitat, the relatively small size of the pools, and industrial development along the river-banks. Occasional periods of poor water quality further reduce the value of fishery habitat. However, valuable habitat for upland species can be found on the wooded bluffs along Pool 1. Sport fishing is common in the pools despite the relative lack of quality fishery habitat. Firearm restrictions prohibit hunting in the urban areas.

Fishery habitat is limited but generally good in Pool 2 upstream of downtown St. Paul. However, the quality of fishing declines in the lower portions of the Minnesota River and downstream portions of Pool 2 because of poor water quality. Valuable wildlife habitat can be found in the areas of Crosby Lake, Pigs Eye Lake, and Grey Cloud Island and on the Minnesota River within the Minnesota Valley National Wildlife Refuge and Black Dog Lake. Pigs Eye Lake, located in Pool 2 downstream of downtown St. Paul, has a unique heron-egret rookery located at its border. This rookery is maintaining itself and contains black-crowned night herons, great blue herons, and common egrets.

Sport fishing is provided in the tailwater areas of locks and dam 1 and at the outfall of Black Dog Lake. Hunting is prohibited in the majority of Pool 2 and on the Minnesota River within the metropolitan area.

Pool 3 has a small but important commercial fishery in North and Sturgeon Lakes. Sport fishing is also good throughout much of Pool 3 and the St. Croix River, especially in some of the backwater lakes. Hunting is a popular sport around Pool 3. Bag checks by the Minnesota Department of Natural Resources indicate waterfowl harvests are comparable to the state average.

Several federally designated endangered or threatened species have been known to occur in this general area of the Upper Mississippi River. The bald eagle (*Haliaeetus leucocephalus*), a threatened species, winters on the Upper Mississippi River, concentrating below dams or near the mouths of tributaries where fish provide a ready food supply. Also, the endangered Higgin's eye pearly mussel (*Lampsilis higginsi*) inhabits portions of the Mississippi and Minnesota Rivers. Historically, the endangered peregrine falcon (*Falco peregrinus*) has also been known to occur in this general area.

These endangered species comments constitute informal consultation only. They do not fulfill the requirements of Section 7 of the Endangered Species Act, as amended. Enclosed is a discussion of federal agencies' major responsibilities under the act.

Concerns

Construction and operation of hydropower facilities at lock and dam 2 and lower St. Anthony Falls will impact fish and wildlife resources, the extent of which must eventually be documented should the projects appear feasible. A major concern involves potential effects to existing daily and seasonal water levels. A change in such levels could result in adverse impacts to wetlands, backwater areas, shoreline habitat, and associated fish and wildlife resources. Regardless of a change in water levels, the location of the generating facilities and their operation could alter existing flow patterns which are fairly uniform across the river. Concentrating a portion of this flow through the generating facilities could affect existing upstream and downstream flow patterns, terrestrial and aquatic habitats, possibly increase scouring and erosion, and affect the existing tailwater sport fisheries. We would be particularly concerned about this funneling effect during low flow periods.

We are also concerned with potential injury and mortality of aquatic organisms due to entrainment through the generating facilities. Impingement of organisms may also be an important factor if screening devices are used at the intakes. In addition to design, construction, and operation of the generating facilities, construction of required transmission lines, corridors, and other facilities could also result in adverse impacts to fish and wildlife resources.

The above concerns should be adequately addressed in future studies if the addition of generating facilities appears economically feasible. We also suggest the projects be closely coordinated with the Minnesota Department of Natural Resources. We appreciate the opportunity to offer our comments on these projects and look forward to our continued coordination on this matter.

Sincerely,

Richard A. Tolbers

for Richard F. Berry
Field Office Supervisor

Attachment

cc: U.S. EPA, Chicago
Minn. DNR, St. Paul

NCSED-PB 5 March 1981

Mr. Lawrence Coffill
Regional Engineer
Federal Energy Regulatory Commission
Federal Building - 31st Floor
230 South Dearborn Street
Chicago, Illinois 60604

Dear Mr. Coffill:

This is in reference to our reconnaissance study for addition of hydropower at Locks and Dam 2 at Hastings, Minnesota.

We have tentatively selected three alternative scales of development for analysis in the reconnaissance report. Installed capacities for these alternatives are 5, 8, and 10 megawatts, respectively. Attached is a table showing firm power estimates for each alternative for the December-January and July-August critical periods. Power duration curves for the critical periods, a weekly generation schedule for the three alternatives being considered, and the flow duration curve for Locks and Dam 2 are also inclosed.

Please furnish project specific power values based on the information in the inclosures. If you have any questions, please call Mr. Al Bjorkquist, study manager (612-725-7494), or Mr. Gordon Heitzman of our Hydrology Section (612-725-5904).

Sincerely,

4 Incl
As stated

LOUIS KOWALSKI
Chief, Planning Branch
Engineering Division

FEDERAL ENERGY REGULATORY COMMISSION
CHICAGO REGIONAL OFFICE
230 SOUTH DEARBORN STREET. ROOM 3130
CHICAGO. ILLINOIS 60604

April 13, 1981

Mr. Louis Kowalski
Chief, Planning Branch
Engineering Division
St. Paul District
Corps of Engineers
1135 U.S. Post Office & Customs House
St. Paul, Minnesota 55101

Dear Mr. Kowalski:

Your March 5, 1981 letter requests our analysis of the value of power at Lock & Dam No. 2 located on the Mississippi River. The project would consist of a 5, 8, or 10 megawatt hydroelectric installation and could produce 31,106, 38,057 or 40,858 megawatt-hours of energy annually.

Using a coal-fueled steam-electric plant as the most likely alternative to the proposed hydroelectric project, power values are summarized in the attached table. These are "at market" values; no transmission line costs for the hydroelectric development have been included. All values are based on October 1, 1980 levels and reflect the following general assumptions:

Basis for Measuring Power Value

Power values are the benefits produced by a hydroelectric plant and reflect a measure of society's "willingness to pay" for the power produced. Because willingness to pay cannot be directly measured, power values are based on the surrogate costs of constructing and operating the most likely alternative if the hydroelectric project is not constructed. This cost is given as the investment cost (capacity value) necessary to construct the most likely alternative and the production cost (energy value) which results from operation of the alternative.

Power values are based on an analysis of the difference in "system" costs resulting from the system being operated using the alternative and using the proposed hydropower addition. System operating costs for each of these cases are simulated using a probabilistic production costing computer model. The POWRSYM Version 48 production costing model was used for this analysis.

Electric "System" Simulated Using the Model

The Northern States System, as projected to exist in 1990, was selected as the "system" simulated using the production costing model. For 1990, the total energy requirement for this utility is projected to be 34,300,000 megawatt-hours with a peak load of 7,710 megawatts expected to occur during the summer period.

Adjustment Factors Applied to Power Values

The capacity values include a credit of 5 percent to reflect the greater operating flexibility of the hydroelectric plant. In addition, the capacity values for the several proposals have been adjusted by -8, -21, and -28 percent, respectively, to incorporate the relative value of the hydroelectric plant capacity based on its availability in comparison with the availability of the alternative coal-fueled steam-electric plant. Accordingly, the capacity values given in the attached table are applicable to the installed capacity of the proposed hydroelectric plants and already incorporate the consideration of dependable capacity.

The energy values given in the attached table reflect the inclusion of the "energy value adjustment" which results from the difference in annual "system" energy production between the steam-electric alternative and the hydroelectric project. Energy values are given based on both current fuel cost levels and on projected real fuel cost increases. Real fuel cost escalation factors were taken from Department of Energy data published October 27, 1980 in the Federal Register, Part XII. Real fuel costs were increased at the rate of 9.55 percent per year for the period 1981-1985, 1.66 percent for 1986-1990, and 0.61 percent for 1991-2010. Costs beyond 2010 were assumed to remain constant at the year 2010 level. Escalated costs assume a 1990 project-on-line date. Costs were levelized over the 100 year life of the hydroelectric plant using 7-3/8, 8-1/2, 10, and 12 percent costs of money.

If you have any questions regarding these power values, please contact Mr. David Simon of my staff at (FTS) 353-6701 and he will assist you.

Sincerely,

Clifford P. Cunningham

for Lawrence F. Coffill, P.E.
Regional Engineer

Enclosure: attached
As stated

POWER VALUE SUMMARY
Lock & Dam No. 2, Mississippi River
October 1, 1980 Cost Base and 7-3/8%, 8-1/2%, 10%, & 12% Cost of Money)

Alternative 1 - 5,000 kW Installation	Cost of Money			
	7-3/8%	8-1/2%	10%	12%
Capacity Value (based on installed capacity)	$91.25/kW-yr	104.05	122.20	149.50
Energy Value -				
Current Fuel Costs	$13.4/MWh	13.4	13.4	13.4
Escalated Real Fuel Costs	$22.8/MWh	22.7	22.6	22.4

Annual Hydroelectric Benefit

7-3/8% - Cost of Money

Capacity Benefit 5,000 kW @ $91.25/kW-yr	$ 456,250
Energy Benefit 31,106 MWh @ $22.8/MWh	$ 709,217
Total Annual Benefit	$1,165,467

8-1/2% - Cost of Money

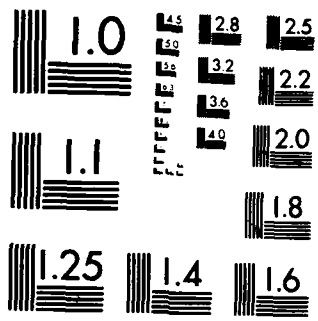
Capacity Benefit 5,000 kW @ $104.05/kW-yr	$ 520,250
Energy Benefit 31,106 MWh @ $22.7/MWh	$ 706,106
Total Annual Benefit	$1,226,356

10% - Cost of Money

Capacity Benefit 5,000 kW @ $122.20/kW-yr	$ 611,000
Energy Benefit 31,106 MWh @ $22.6/MWh	$ 702,996
Total Annual Benefit	$1,313,996

12% - Cost of Money

Capacity Benefit 5,000 kW @ $149.50/kW-yr	$ 747,500
Energy Benefit 31,106 MWh @ $22.4/MWh	$ 696,774
Total Annual Benefit	$1,444,274



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Alternative 2 - 8,000 kW Installation	Cost of Money			
	7-3/8%	8-1/2%	10%	12%
Capacity Value (based on installed capacity)	$79.00/kW-yr	90.10	105.80	129.50
Energy Value -				
Current Fuel Costs	$13.6/MWh	13.6	13.6	13.6
Escalated Real Fuel Costs	$23.1/MWh	23.0	22.9	22.7

Annual Hydroelectric Benefit

7-3/8% - Cost of Money

Capacity Benefit 8,000 kW @ $79.00/kW-yr	$ 632,000
Energy Benefit 38,057 MWh @ $23.1/MWh	$ 879,117
Total Annual Benefit	$1,511,117

8-1/2% - Cost of Money

Capacity Benefit 8,000 kW @ $90.10/kW-yr	$ 720,800
Energy Benefit 38,057 MWh @ $23.0/MWh	$ 875,311
Total Annual Benefit	$1,596,111

10% - Cost of Money

Capacity Benefit 8,000 kW @ $105.80/kW-yr	$ 846,400
Energy Benefit 38,057 MWh @ $22.9/MWh	$ 871,505
Total Annual Benefit	$1,717,905

12% - Cost of Money

Capacity Benefit 8,000 kW @ $129.50/kW-yr	$1,036,000
Energy Benefit 38,057 MWh @ $22.70/MWh	$ 863,894
Total Annual Benefit	$1,899,894

Alternative 3 - 10,000 kW Installation	Cost of Money			
	7-3/8%	8-1/2%	10%	12%
Capacity Value (based on installed capacity)	$72.40/kW-yr	82.60	97.00	118.70
Energy Value -				
Current Fuel Costs	$13.5/MWh	13.5	13.5	13.5
Escalated Real Fuel Costs	$22.9/MWh	22.8	22.7	22.6

Annual Hydroelectric Benefit

7-3/8% - Cost of Money

Capacity Benefit 10,000 kW @ $72.40/kW-yr	$ 724,000
Energy Benefit 40,858 MWh @ $22.9/MWh	$ 935,648
Total Annual Benefit	$1,659,648

8-1/2% - Cost of Money

Capacity Benefit 10,000 kW @ $82.60/kW-yr	$ 826,000
Energy Benefit 40,858 MWh @ $22.8/MWh	$ 931,562
Total Annual Benefit	$1,757,562

10% - Cost of Money

Capacity Benefit 10,000 kW @ $97.00/kW-yr	$ 970,000
Energy Benefit 40,858 MWh @ $22.7/MWh	$ 927,477
Total Annual Benefit	$1,897,477

12% - Cost of Money

Capacity Benefit 10,000 kW @ $118.70/kW-yr	$1,187,000
Energy Benefit 40,858 MWh @ $22.6/MWh	$ 923,391
Total Annual Benefit	$2,110,391

MINNESOTA HISTORICAL SOCIETY
FOUNDED IN 1849
690 Cedar Street, St. Paul, Minnesota 55101 • (612) 296-61

16 April 1981

Robert F. Post
Chief, Environmental Resources Branch
Engineering Division
Department of the Army
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Mr. Post:

RE: Review of the proposed work at Lock and Dam No. 2 at Hastings to convert to hydropower, Dakota and Washington Counties.

MHS Referral File Number: M 707

Thank you for the opportunity to review and comment on the above project. It has been reviewed pursuant to responsibilities given the State Historic Preservation Officer by the National Historic Preservation Act of 1966 and the Procedures of the National Advisory Council on Historic Preservation (36CFR800).

This review reveals that there are no recorded historical, architectural, cultural, or archaeological sites located in the vicinity of the proposed project. At this time, it is our opinion that the dam does not qualify for inclusion on the National Register of Historic Places. However, it should perhaps be reviewed for its historical significance in the future. Because there is a possibility that unrecorded prehistoric archaeological sites may exist in the area, we wish to review associated construction plans as they become available.

Thank you for your attention to cultural resources in your planning process.

Sincerely,

Dennis A. Gimmestad
for Russell W. Fridley
State Historic Preservation Officer

RWF/sl

[illegible]-PB   29 April 1981

Mr. Lawrence F. Coffill
Regional Engineer
Federal Energy Regulatory Commission
Chicago Regional Office
230 South Dearborn Street, Room 3130
Chicago, Illinois 60604

Dear Mr. Coffill:

This is in reference to our reconnaissance study for hydropower addition at locks and dam 2 at Hastings, Minnesota.

Our letter of 5 March 1981 regarding this study included information for installed capacities of 5, 8, and 10 megawatts. We have reevaluated the weekly generation schedule that was shown as inclosure 3 of our letter. The revised weekly generation schedule is attached. New generation values do not vary as drastically from week to week as was shown in our previous submission.

We would like the new generation schedule run on your computer model to ascertain if any difference in power values would occur. Since we intend using values included in your 13 April 1981 letter for the reconnaissance report which is nearing completion, power values need only be computed using a 7 3/8-percent cost of money.

If you have any questions, please call Mr. Al Bjorkquist, study manager (612-725-7494), or Mr. Gordon Heitzman of our Hydrology Section (612-725-5904).

Sincerely,

1 Incl
As stated

LOUIS KOWALSKI
Chief, Planning Branch
Engineering Division

FEDERAL ENERGY REGULATORY COMMISSION
CHICAGO REGIONAL OFFICE
230 SOUTH DEARBORN STREET, ROOM 3130
CHICAGO, ILLINOIS 60604

May 14, 1981

Mr. Louis Kowalski
Chief, Planning Branch
Engineering Division
St. Louis District
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Mr. Kowalski:

As requested in your April 29, 1981 letter, we have re-evaluated the power values at Locks and Dam No. 2 on the Mississipp River using the revised schedule of weekly hydroelectric generation you provided. Based on our analysis, the following power values were determined:

Installed Capacity (MW)	5.0	8.0	10.0
Average Generation (MWh/yr)	31,417	39,671	43,354
Capcity Value ($/kW/yr)	91.25	79.00	72.40
Energy Value - (Mills/kWh)			
Current Fuel Costs	13.9	14.2	14.5
Escalated Real Fuel Costs	23.6	24.3	24.8

The above power values are based on 7-3/8 percent cost of money, October 1, 1980 price levels, and the same general assumptions as described in our April 13, 1981 letter to you.

If you have any questions regarding these power values, please contact Mr. David Simon of my staff at (FTS) 353-6701 and he will assist you.

Sincerely,

Lawrence F. Coffill

Lawrence F. Coffill, P.E.
Regional Engineer

APPENDIX C

HYDROLOGIC POWER
AND
ENERGY ANALYSIS

TABLE OF CONTENTS

PLATES

APPENDIX C

HYDROLOGIC POWER AND ENERGY ANALYSIS

In this reconnaissance study, three options were proposed initially. These options were of 8, 9, and 10 units, each producing 1.0 MW per unit. These selections seemed to provide very little "spread" along the flow duration curve, so it was decided to study the 8- and 10-unit options, and along with them a 5-unit option for the third option. Later, 4-unit and 12-unit options were added to the investigations.

AVERAGE ANNUAL ENERGY

The flow duration technique was used to estimate average annual energy production. The daily flows for the period of record are grouped into flow classes. Each flow class is then plotted according to its cumulative percentage of occurrence. The curve (see plate C01) is assumed to represent an average year.

Since the head varies significantly with changes in flow, 5 years of data (representing wet, damp, average, dry, and very dry years) were compiled to determine a head-versus-flow curve. This gross head was reduced by the estimated trash rack and tailrace losses to produce the curve of estimated net head (also shown on plate C-1).

The power available depends upon the factors of head (H) and flow (Q). The amount of the power produced by the turbine depends upon these factors and the efficiency of the turbine. The following equation is used to calculate the power for each flow class as was shown derived in the main report:

$$P = \frac{Q \times H}{13.7} \qquad \text{(kW)}$$

As previously noted, this equation assumes an overall efficiency of 0.86.

For each flow class along the flow-duration curve the power is calculated for the available flow. If the flow available is different from the design flow, the turbine flow is calculated by the orifice equation to be proportional to the square root of the ratio of the available head to the design head.

The average annual energy (AAE) is represented by the area under the power curve. In plate C-1, power curves have been plotted for all five options. Plates C-2A and 2B show calculations used to derive curves shown on plate C-1. The average annual energy estimate and plant factor for each of the five sizes of plant are:

Size	Average annual energy (MWh)	Plant factor
4	27,100	.77
5	31,000	.71
8	37,500	.54
10	40,200	.47
12	41,700	.40

FIRM POWER EVALUATION

The Federal Energy Regulatory Commission requested the firm power for the two critical periods of July-August and December-January. Firm power is that power which can be relied upon as a minimum during critical periods. Plates C-3 and C-4 show the power duration curves for the critical periods. These curves were provided to FERC for development of power values.

Firm power can also be estimated by an alternative method. The firm power estimate given on plate C-5 is intended to indicate the size of conventional plant which would provide the same dependable capacity on the average. This approach considers (1) the sizes of the conventional and hydro plants and (2) their relative availabilities. The formula used is:

$$\text{Capacity Firm, MW} = \frac{\text{(Installed Capacity)(Hydro plant Factor)}}{\text{(Conventional Plant Reliability)}}$$

Conventional and nuclear plants in this area have reliabilities from 63 to 95 percent, with an average of 83 percent. For this study, the conventional reliability was assumed to equal 85 percent (0.85).

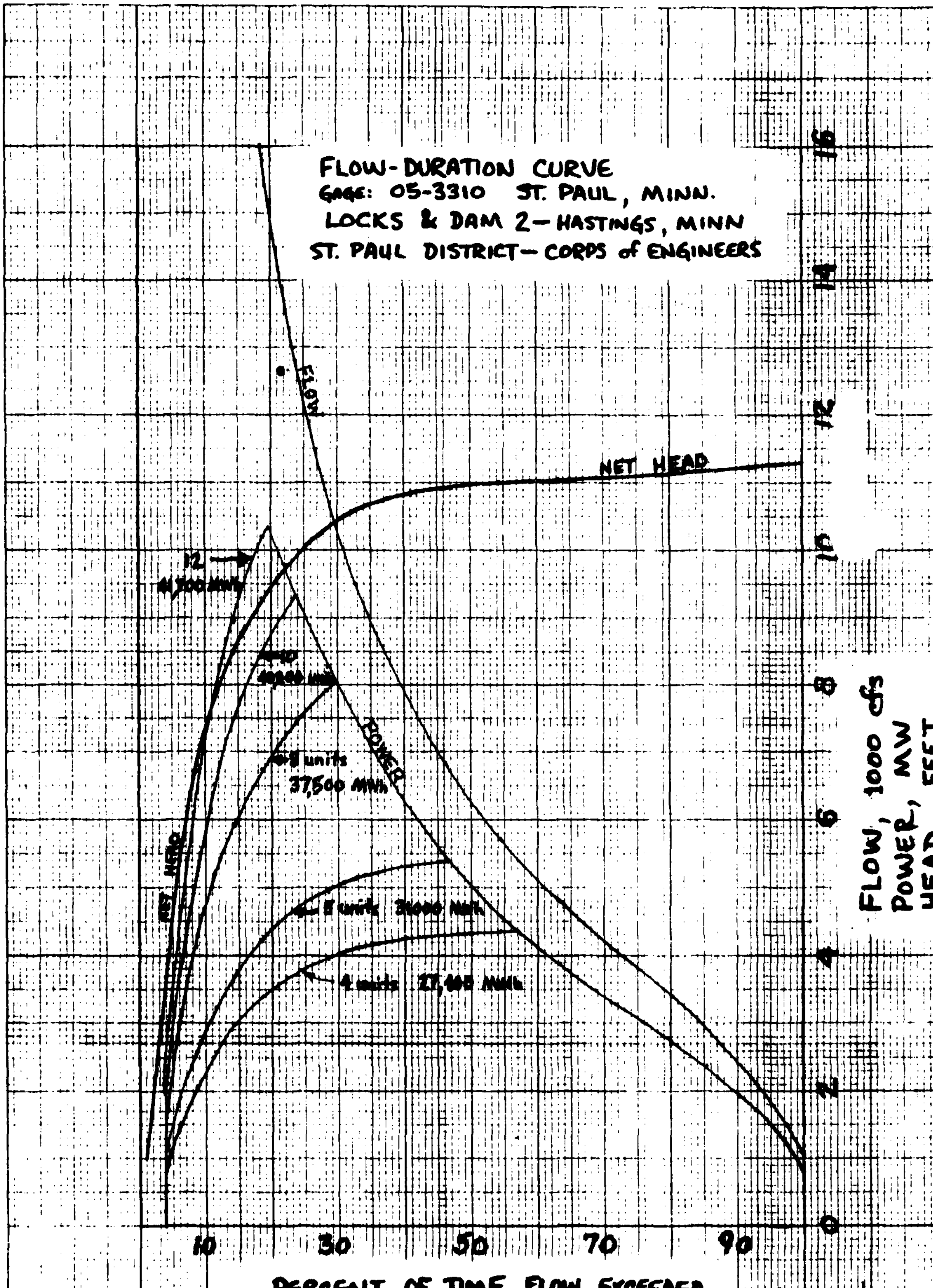
This procedure is that recommended by the staff of the Hydroelectric Design Branch of the North Pacific Division, Corps of Engineers.

AVERAGE WEEKLY GENERATION

To calculate the power values to be assigned to a proposed site, its performance within the proposed power network is simulated by a computer program. In order to do this, the proposed generation schedule is required on a weekly basis.

Estimated weekly average values were composed from monthly averages; the weekly averages were then used to estimate weekly power production.

The use of weekly average flows tends to overestimate the energy production. Values in the table of weekly generation (plate C-6) should be considered as relative, or should be proportionally adjusted to provide corrected average annual energy values. The values shown were those sent to the FERC.



FLOW-DURATION CURVE
GAGE: 05-3310 ST. PAUL, MINN.
LOCKS & DAM 2 — HASTINGS, MINN
ST. PAUL DISTRICT — CORPS of ENGINEERS
FLOW
NET HEAD
POWER
4 units 27,400 MWh
37,500 MWh
NET HEAD
FLOW, 1000 cfs
POWER, MW
HEAD, FEET
0
2
4
6
8
10
12
14
16
10
30
50
70
90
PERCENT OF TIME FLOW EXCEEDED
3/81

PLATE C-1

COMPUTATION SHEET

Subject: LOCK 2 HYDROPOWER RECONNAISSANCE — Project: LOCK & DAM 2

Computation: FLOW-DURATION POWER COMPUTATIONS

Computed by: 3.0 m Allis Chalmers Tube Turbine — Checked by: — Date: — Page ___ of ___ Pages

DESIGN HEAD 3.2 m (10.5 feet)

D/J	J/A	%-ile	FLOW	NET HEAD	# EVENTS 29219	Δ%	5x FLOW	FLOW USED	5x Power KW	5 ENERGY MWh	8x FLOW	FLOW USED	8x POWER KW	8 ENERGY MWh	10x FLOW	FLOW USED	10x POWER KW	ENERGY MWh
	.3	1.0	52000	< 3'	140													
	.9	2.2	44000	< 3'	365													
	2.3	3.9	37000	3.7	488	1.67	3939	3939	1064	156	6302	6302	1702	249	7877	7877	2127	311
	4.2	6.0	31000	5.4	606	2.07	4758	4758	1875	341	7613	7613	3001	545	9516	9516	3751	681
	7.6	8.7	26000	6.7	782	2.68	5300	5300	2592	608	8480	8480	4147	972	10600	10600	5184	1216
	10.6	11.3	22000	7.8	768	2.63	5719	5719	3256	750	9150	9150	5209	1199	11437	11437	6512	1499
	13.9	14.5	19000	8.55	932	3.19	5987	5987	3737	1044	9580	9580	5979	1671	11975	11975	7473	2088
.4	19.4	18.5	16000	9.3	1161	3.97	6244	6244	4239	1475	9991	9991	6782	2361	12489	12489	8478	2951
.7	26.0	23.7	13000	9.9	1522	5.21	6443	6443	4656	2124	10308	10308	7449	3399	12885	12885	9311	4249
2.2	31.6	28.3	11000	10.3	1354	4.63	6572	6572	4941	2006	10514	10514	7905	3209	13143	*11000	8270	3357
4.7	37.9	32.7	9500	10.6	1268	4.34	6667	6667	5158	1961	10666	*9500	7350	2794	13333	*9500	7350	2794
9.5	45.8	39.5	8000	10.8	1992	6.82	6729	6729	5305	3168	10767	*8000	6307	3766	13458	*8000	6307	3766
14.1	53.7	46.2	6800	10.9	1967	6.73	6760	6760	5379	3172	10816	*6800	5410	3190	13520	*6800	5410	3190
22.7	62.9	54.5	5700	11.0	2429	8.31	6791	*5700	4577	3333	10866	*5700	4577	3333	13582	*5700	4577	3333
33.4	71.2	63.3	4800	11.1	2560	8.76	6822	*4800	3889	2985	10915	*4800	3889	2985	13644	*4800	3885	2985
45.5	78.6	71.0	4100	11.1	2256	7.72	6822	*4100	3322	2247	10915	*4100	3322	2247	13644	*4100	3322	2247
60.2	85.9	80.1	3400	11.1	2663	9.11	"	*3400	2755	2199	10915	*3400	2755	2199	13644	*3400	2755	2199
70.6	89.1	85.7	2900	11.2	1640	5.61	6853	*2900	2371	1166	10964	*2900	2371	1166	13705	*2900	2371	1161
80.1	92.3	90.3	2400	11.2	1326	4.54	"	*2400	1962	780	"	*2400	1962	780	"	*2400	1962	780
86.3	94.4	92.9	2100	11.2	759	2.60	"	*2100	1717	682	"	*2100	1717	682	"	*2100	1717	682
92.3	96.8	95.9	1700	11.25	890	3.01	6868	*1700	1396	368	10989	*1700	1396	368	13736	*1700	1396	368
95.0	97.6	97.3	1500	11.25	424	1.45	"	*1500	1232	157	"	*1500	1232	157	"	*1500	1232	157
98.6	98.6	99.2	1200	11.3	536	1.83	6883	*1200	990	159	11013	*1200	990	159	13766	*1200	990	159
99.4	98.9	99.5	1100	11.3	102	0.35	"	*1100	907	28	"	*1100	907	28	"	*1100	907	28
99.9	99.4	99.8	890	11.3	88	0.30	"	*890	734	19	"	*890	734	19	"	*890	734	19
	99.8	100	750	11.3	42	0.14	"	*750	619	8	"	*750	619	8	"	*750	619	8
								TOTALS		30935				37487				40234
			Average	Annual	Energy	Totals				31,000 MWh				37500 MWh				40200 MWh
					PLANT	FACTOR	—			.71				.54				.47

.77 4 UNITS

NCS Form 53
17 Aug 77

U.S. GPO 1978 785-137 60 Region no. 6

Plate 2-A

COMPUTATION SHEET

Subject: ANNUAL FLOW-DURATION HYDROPOWER ANALYSIS FOR: Project: ____
Computation: LOCK & DAM 2 ADDITIONAL OPTIONS – 4-and 12-unit options
Computed by: DESIGN HEAD 10.5 ft Checked by: ____ Date: ____ Page ___ of ___ Pages

%-ile	Flow	Net Head	#Events 29219	Δ%	4 UNITS @ 1.0 MW Flow Capacity	4 UNITS Flow Used	4 UNITS Power KW	4 UNITS Energy MWh	12 UNITS @ 1.0 MW Flow Capacity	12 UNITS Flow Used	12 UNITS Power KW	12 UNITS Energy MWh	16 UNITS @ 1.0 MW Flow Capacity	16 UNITS Flow Used	16 UNITS Power KW	16 UNITS Energy MWh
1.0	52000	<3'	140													
2.2	44000	<3'	365													
3.9	37000	3.7	488	1.7	3151	3151	851	125	9453	9453	2553	374	12604	12604	3404	498
6.0	31000	5.4	606	2.1	3807	3807	1500	273	11420	11420	4501	818	15226	15226	6002	1090
8.7	26000	6.7	782	2.7	4240	4240	2074	486	12720	12720	6221	1458	16960	16960	8294	1945
11.3	22000	7.8	768	2.6	4575	4575	2605	606	13725	13725	7814	1799	18300	18300	10419	2399
14.5	19000	8.55	932	3.2	4790	4790	2989	835	14369	14369	8768	2506	19159	19000	11858	3313
18.5	16000	9.3	1161	4.0	4995	4995	3391	1180	14986	14986	10173	3541	19982	16000	10861	3781
23.7	13000	9.9	1522	5.2	5154	5154	3765	1700	15462	13000	9394	4287	20616	13000	9394	4287
28.3	11000	10.3	1354	4.6	5257	5257	3152	1604	15772	11000	8270	3357	21029	11000	8270	3357
32.7	9500	10.6	1268	4.3	5333	5333	4126	1569	16000	9500	7350	2794	21333	9500	7350	2794
39.5	8000	10.8	1992	6.8	5383	5383	4344	2534	16150	8000	6307	3766	21533	8000	6307	3766
46.2	6800	10.9	1967	6.7	5408	5408	4303	2537	16224	6800	5410	3190	21633	6800	5410	3190
54.5	5700	11.0	2439	8.3	5433	5433	4362	3177	16299	5700	4577	3333	21732	5700	4577	3533
63.3	4800	11.1	2560	8.8	5458	4800	3889	2985	[illegible]	4800	3889	2985	21830	4800	3889	2985
71.0	4100	11.1	2256	7.7	5458	4100	3322	2247	16373	4100	3322	2247	21830	4100	3322	2247
80.1	3400	11.1	2663	9.1	5458	3400	2755	2199	16373	3400	2755	2199	21830	3400	2755	2199
85.7	2900	11.2	1640	5.6	5482	2900	2371	1166	16446	2900	2371	1166	21928	2900	2371	1166
90.3	2400	11.2	1326	4.5	5482	2400	1962	780	16446	2400	1962	780	21928	2400	1962	780
92.9	2100	11.2	759	2.6	5482	2100	1717	391	16446	2100	1717	391	21928	2100	1717	391
95.9	1700	11.25	880	3.0	5494	1700	1396	368	16483	1700	1396	368	21977	1700	1396	368
97.3	1500	11.25	424	1.5	5494	1500	1232	157	16483	1500	1232	157	21977	1500	1232	157
99.2	1200	11.3	536	1.8	5506	1200	990	159	16519	1200	990	159	22026	1200	990	159
99.5	1100	11.3	162	0.3	5506	1100	907	28	16519	1100	907	28	22026	1100	907	28
99.8	890	11.3	88	0.3	5506	890	734	19	16519	890	734	19	22026	890	734	19
100.0	750	11.3	42	0.1	5506	750	619	8	16519	750	619	8	22026	750	619	8
						TOTALS		27126				41730				44260
		AVG ANNUAL ENERGY, MWh						27100				41700				44300
		OVERALL PLANT FACTOR						.77				.40				.32
		INCREMENTAL PLANT FACTOR						N/A			Overexisting	.21			Overexisting	.16
											Over 10 MW	.09			Over 12 MW	.07

NCS Form 53
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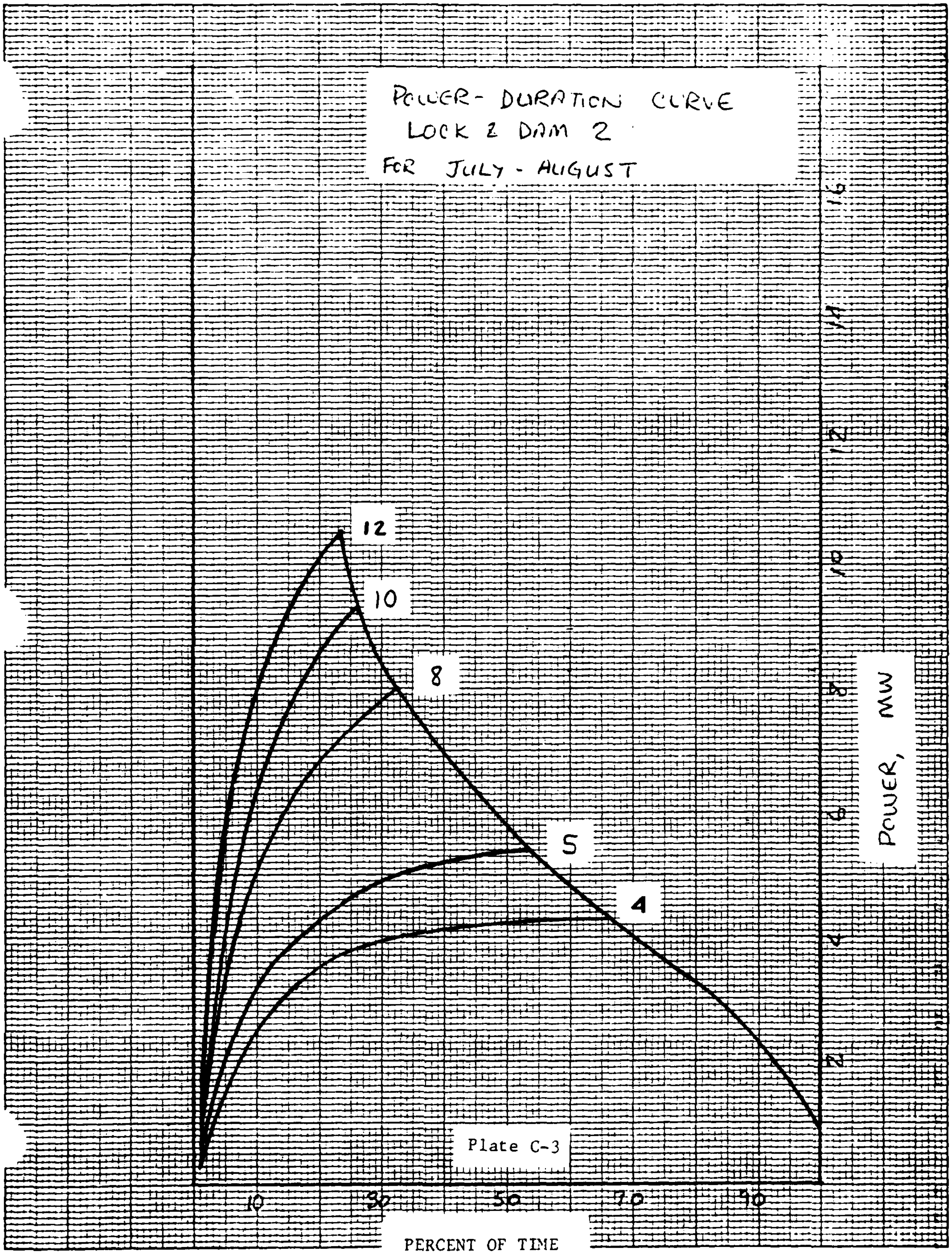
Plate 2-B



PERCENT OF TIME

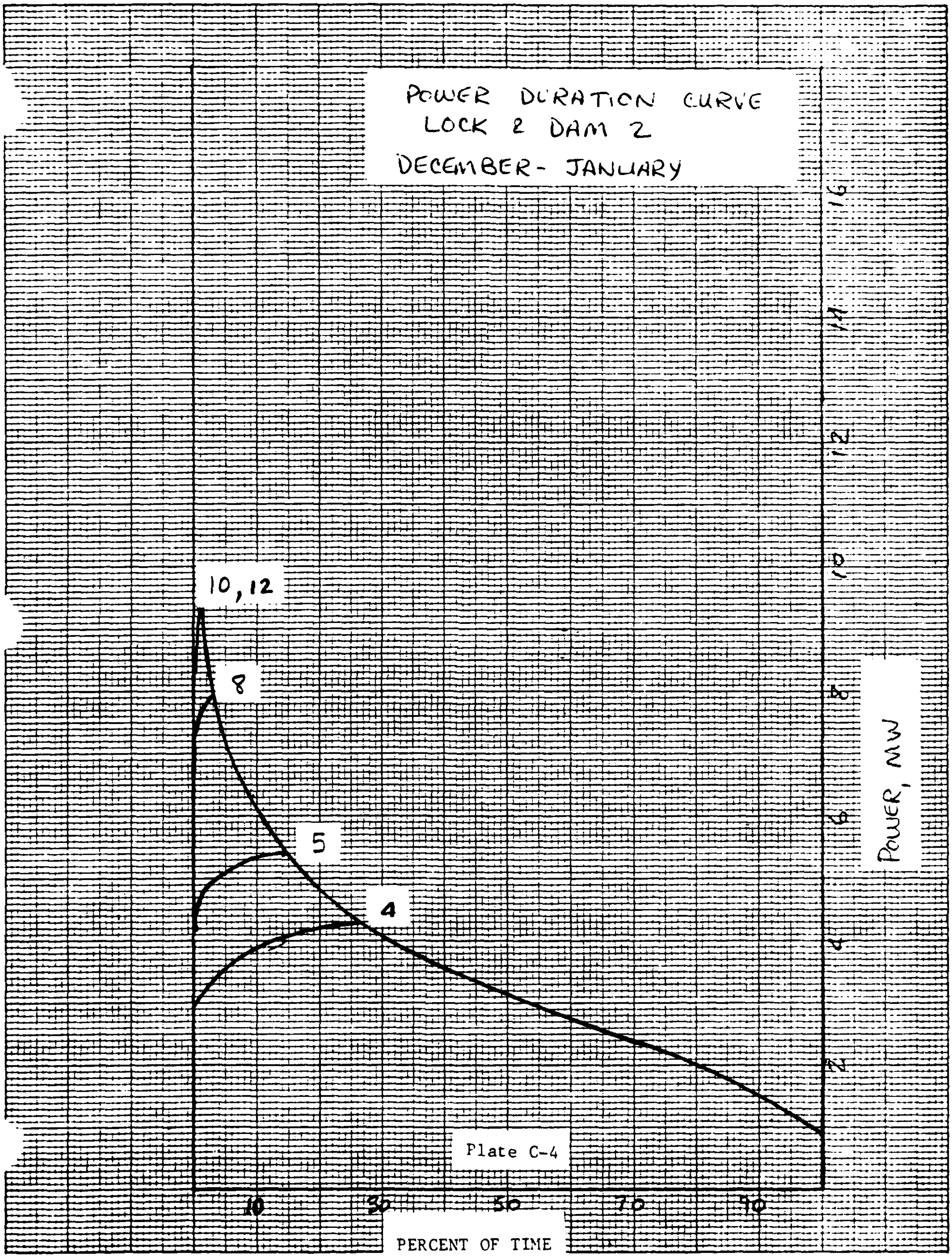


Plate C-4

PERCENT OF TIME

Firm Power Estimate (MW)

Lock and Dam 2

Period	Option 4 MW	5 MW	8 MW	10 MW	12 MW
Dec-Jan	3.1	3.8	4.0	4.1	4.1
All year	3.6	4.2	5.1	5.5	5.6
July-Aug	3.7	4.5	5.7	6.2	6.6

Plate C-5

COMPUTATION SHEET

NAME OF OFFICE	COMPUTATION	DATE	PAGE OF PAGES
SUBJECT LOCK & DAM 2 WEEKLY GENERATION SCHEDULE FOR F.E.R.C			PRICE LEVEL
COMPUTED BY JSH 2-81	CHECKED BY	APPROVED BY	

WEEK	FLOW / HEAD	5 units	8 units	10 units	WEEK	FLOW / HEAD	5 units	8 units	10 units
1	5900/11.0	796	796	796	27	26500/6.6	426	681	851
2	4400/11.1	599	599	599	28	15000/9.5	735	1176	1470
3	3400/11.15	465	465	465	29	3300/11.15	451	451	451
4	1600/11.3	222	222	222	30	8000/10.8	891	1060	1060
5	6400/10.9	855	855	855	31	14000/9.7	759	1214	1517
6	2800/11.2	385	385	385	32	3000/11.15	410	410	410
7	1260/11.3	175	175	175	33	9400/10.6	867	1222	1222
8	6100/11.0	823	823	823	34	5300/11.0	715	715	715
9	4500/11.1	613	613	613	35	10500/10.5	854	1352	1352
10	3200/11.15	438	438	438	36	2600/11.2	357	357	357
11	4200/11.1	572	572	572	37	4000/11.1	544	544	544
12	7300/10.9	904	976	976	38	6700/10.9	896	896	896
13	34900/4.3	224	358	448	39	16200/9.3	712	1139	1424
		7068	7275	7364			8617	11217	12270
14	23500/7.4	505	809	1011	40	12000/10.1	806	1290	1486
15	54600/—	—	—	—	41	3900/11.1	531	531	531
16	8400/10.7	879	1102	1102	42	7600/10.8	891	1007	1007
17	5600/11.0	755	755	755	43	2200/11.2	302	302	302
18	30200/5.4	315	504	630	44	19300/8.5	622	996	1244
19	13000/9.9	782	1251	1564	45	7000/10.9	904	936	936
20	11100/10.3	830	1328	1402	46	3600/11.15	492	492	492
21	9900/10.6	867	1287	1287	47	2400/11.2	330	330	330
22	43000/—	—	—	—	48	5100/11.0	688	688	688
23	21200/8.0	568	909	1136	49	8900/10.7	879	1168	1168
24	17600/9.0	678	1085	1356	50	4700/11.05	637	637	637
25	4900/11.05	664	664	664	51	3700/11.1	504	504	504
26	5400/11.0	728	728	728	52	1900/11.3	263	263	263
		7571	10423	11636			7848	9142	9587
		14640	176[illegible]	19000			31106	38057	40858
							MWh	MWh	MWh

Plate C-6

NCS Form 18 22 Dec. 75

APPENDIX D

PLAN OF STUDY

TABLE OF CONTENTS

FIGURES

APPENDIX D

PLAN OF STUDY

REPORTS DEVELOPED

STAGE I - RECONNAISSANCE STUDY

The study for hydropower addition will be conducted in two stages. During the first stage, principal emphasis is on identification of resource management problems, concerns, and opportunities. Because of the introductory nature of the planning process in this stage, the effort involves analyzing a wide range of data, which may be more qualitative than quantitative. The general purpose of this stage is to initially analyze the water and related management problems and opportunities and evaluate in a preliminary fashion alternative solutions. The product of Stage I is a reconnaissance report which shows the results of the analysis; recommends or terminates further study; and, if further studies are recommended, outlines a plan for future studies.

STAGE II - FEASIBILITY STUDY

The feasibility report analyzes differences among alternatives and the corresponding effects of trade-offs between the national economic development and environmental quality objectives. Major study efforts will involve collection and evaluation of required data and formulation of an optimum scale of development. Recommendations will be made in the report for authorization of the plan selected. However, the authorization by Congress, advance planning, and funding by Congress will be necessary before any of the measures recommended in the feasibility report could be developed.

a. At the completion of the reconnaissance study, when alternative solutions are known but before a plan has been tentatively selected, a midstudy public meeting will be held. A major purpose of this meeting is to present the results of preliminary studies including the advantages and disadvantages of the various alternatives to the extent that such information has been developed and to further develop public views and desires, particularly as they relate to the various alternatives.

b. A late-stage public meeting will be held after detailed studies and before feasibility report completion. Findings of the detailed studies, including the rationale for any proposed solution, and the tentative recommendations will be presented. This meeting will ensure that any plan presented would be acceptable.

STUDIES REQUIRED

PLANNING

Planning studies will assess the power potential and issues related to its development. Alternative solutions will be investigated. Current formulation criteria and policies will be used to evaluate the development of alternative plans incorporating both nonstructural[1] and structural measures as appropriate. Analysis of alternatives and impacts of trade-offs among national economic development, environmental quality, and social well-being will be assessed in selection of the best solution. The major study effort will be to select a final plan that best meets overall needs and formulate the optimum scale of project development. As an integral part of the planning effort, coordination will be maintained with the public throughout all stages of the study. Report preparation and development will be a specific responsibility of this study element. Also, by using sound planning practices the study schedule will be maintained.

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(1) Nonstructural alternatives are not required for small-scale hydropower projects of 25 MW or less.

ECONOMIC AND FINANCIAL ANALYSIS

The economic analysis deals primarily with development and application of benefit-cost analysis which is the most frequently used and accepted procedure for project economic evaluation. The objective of this analysis is to relate all project economic benefits to all project costs accruing to the project.

Studies to evaluate the economic worthiness of the project will include formulation of alternative project cost and benefit streams, screening and ranking of alternatives, benefit-cost analysis, and determination of risk and uncertainty related to project outcomes.

Average annual costs, using current interest rates, will be determined within the St. Paul District office. Annualized power value benefits will be supplied by the Federal Energy Regulatory Commission (see the section entitled "Power Value Analysis" in this appendix).

Financial feasibility deals with a project's ability to obtain funds for implementation and repay these funds on a self-liquidating basis. If the project is financed and operated by the Federal Government, financial feasibility loses meaning because the project does not have to be self-liquidating in the short run and federally established interest rates would be used for financial comparison. In this case, the economic and financial analysis would essentially be the same.

A financial analysis for the project, however, will be done based on non-Federal funding and operation. This analysis will consider the overall credit market at the time of study completion as it relates to possible funding of a hydroproject; inflation factors and how they affect the cost of capital, cash receipts, and cash disbursements; and determination of the project's minimum reverse requirement including a sensitivity analysis of risk.

ENGINEERING

The types of engineering studies that will be performed include hydrologic power evaluation, foundation, mechanical and electrical, civil features, and design and cost studies. All of the studies undertaken will be accomplished using appropriate engineering standards, regulations, and guidelines and will be summarized in a report appendix for each study.

Hydrologic Power Evaluation

Hydrologic power evaluation establishes how much water can be diverted through the turbines and the hydraulic head associated with this flow. Studies for evaluation of power will essentially be an update and refinement of the technique used in the reconnaissance study.

Related studies concerning the flow pattern changes resulting from hydropower plant construction may be required. However, provision for a physical model study which would completely evaluate flow changes is not included in the work schedule and cost estimate section of this appendix. Such a study is considered unwarranted at this time.

Foundation Studies

Foundation studies will consist of the necessary instrument surveys to supplement existing boring and topography information in areas of any considered improvements. Sufficient foundation investigations will be made to determine the type and engineering characteristics of soils in any development area from field examinations of exposed cuts and channel banks and from research of existing available boring data. Additional soil borings and subsequent tests will be completed as appropriate.

Power plant channel design will include riprap if necessary. Final design of riprap will determine gradation, thickness, size and extent, and other erosion or scour preventive features. These designs will conform to current design methods and criteria.

Embankments will be designed which are safe against overtopping during occurrence of the design flood and stable and safe under extremes of operation. The embankments will be designed so as not to impose excessive stresses on the foundation materials, have slopes that are stable under all conditions of impoundment operations, and provide for control of seepage through the embankment foundation and abutments as necessary. Final designs will conform to current design criteria.

Mechanical and Electrical Features

Mechanical and electrical features convert the water's energy to electricity. These features also control the energy and transmit it to a power grid.

Studies will include evaluation of major equipment items such as the hydraulic turbines; electrical generators; and a switchyard consisting of a transformer, circuit breaker, and switchgear. Included also are supporting systems which control and protect these major equipment items. Evaluation of maintenance facilities such as a crane for lifting is also included under mechanical and electrical features investigations.

Because of plant size and likely marginal economic feasibility, standardized turbines and complete generating sets will be evaluated for application. In addition, relaxing the need for some of the traditional control and protection equipment will be assessed.

Civil Features

The civil features of small hydropower additions include site preparation works, hydraulic conveyance facilities, and powerhouse and appurtenant facilities.

Site preparation includes grading, foundation excavation, drainage and erosion control, access roads and parking facilities, and construction noise abatement and dust control. Hydraulic conveyance facilities include penstocks, tunnels, canals, valves and gates, inlet and outlet works, and tailraces.

Powerhouse and appurtenant facilities include all structures for powerhouse and equipment handling facilities, foundations for both the powerhouse and switchyard, and fencing around the project area.

The civil features of small hydropower additions differ from those of major hydropower installations. Feasibility of the project may hinge upon adequate yet innovative designs for civil features. Therefore, studies in addition to evaluating the above features will include the analysis of appropriate outdoor type plants, portable lifting equipment for maintenance, and reduction in normal protection equipment.

Designs and Cost Estimates

Detailed project scope structural designs for all alternative features will be undertaken. Such designs will be in accordance with accepted criteria and guidelines. Design work will also include drafting of all report charts, illustrations, and plates in accordance with drafting standards. A detailed estimate of first costs will be accomplished including appropriate allowances for advance engineering, design, and contingencies. The estimates of first costs will reflect prevailing price levels for similar work in the area and be based on recent price information. An estimate of annual costs including appropriate allowances for operation, maintenance, and scheduled replacement of major project features will be prepared. These annual costs will be based on the interest rate prevailing at the time of report completion.

MARKETING ANALYSIS

The Department of Energy (DOE) is responsible for performing market analysis for Federal hydropower projects. The DOE will be provided a copy of this reconnaissance report and other data it believes it needs to complete its analysis. Its output would be a statement that power which the project would produce could be marketed at a price that would ensure repayment of project costs plus interest and operation, maintenance, and major replacement costs within the required 50-year period. Results of the marketing analysis will be included in the feasibility study.

POWER VALUE ANALYSIS

Hydroelectric developments must be planned and evaluated as components of comprehensive river basin plans as well as units of the electric power supply systems in which they are incorporated. In regard to the above, the Federal Energy Regulatory Commission (FERC) provides input to determine financial and economic feasibility of Federal hydropower projects.

Benefits attributable to the hydropower projects are determined and furnished by FERC in close coordination with the DOE and will be used in the above-mentioned economic and financial feasibility analysis. Power values are the benefits produced by a hydroelectric plant and reflect a measure of society's willingness to pay for the power produced. Because willingness to pay cannot be directly measured, power values are based on the surrogate costs of constructing and operating the most probable alternative if the hydropower project is not constructed. This cost is given as an investment cost (capacity values) necessary to construct the most probable alternative and the production cost (energy value) which results from operation of the alternative.

ENVIRONMENTAL RESOURCES

The potential for hydropower development is being investigated at several of the locks and dams within the district. Environmental studies will be undertaken to identify the impacts of alternatives on the natural and human environment. Specific studies will be undertaken in the categories of natural resources, cultural resources, and social effects.

Natural Resources

The objectives of natural resources studies would be to:

a. Identify the principal natural resources of the study area.

b. Determine those significant resources which would be affected by hydropower development.

c. Predict the potential environmental impacts of each alternative.

d. Identify opportunities for restoration and enhancement of the environment.

e. Recommend strategies for minimizing or eliminating impacts.

Natural resources studies conducted at one or more of the dams would be applicable to all because of the basic similarities among all the structures.

The tail water, the area immediately downstream of a dam, provides a valuable and heavily utilized fishery resource at many of the dams on the Upper Mississippi River. Studies would be conducted to determine what factors (e.g., current velocity, water depth) are of critical importance to the fishery and what effect the installation of hydropower would have on those factors.

The diversion of the majority of the river flow through turbines would have the potential to reduce dissolved oxygen levels. Studies would be made to predict possible reductions by determining existing oxygen values. Methods of improving aeration during power generation would be investigated.

An area of concern in power generation is the potential for entrainment (organisms drawn toward or into the turbine tube) or impingement (organisms trapped on trash collection screens). The possible extent of entrainment and impingement would be investigated. Screening and intake designs which would minimize the effects would be reviewed as well.

It is known that various species of fish, including white bass and sauger, move upstream from pool to pool. The extent and importance of this movement is not well understood. The effect of hydropower development on this phenomenon and the consequences would be investigated.

The placement of cofferdams and other excavated material as well as excavation itself (e.g., headrace, tailrace channels) would be detrimental to aquatic communities through habitat destruction or burial of organisms. The possible extent of such activities and methods of minimizing them would be investigated.

Studies would also be conducted to evaluate impacts on the unique significant resources of each individual hydropower site. Opportunities to restore or enhance previously disrupted resources would be sought at each individual site.

Recreation

The recreation studies will investigate and document any recreation resource related needs, as identified by prior studies, that could be satisfied by feasible recreation features incorporated in the national economic development, environmental quality, and recommended plans of improvement. Appropriate drawings, sketches, or illustrations showing any proposed recreation facilities will be included in the feasibility report along with associated cost estimates. The location and extent of any lands required for recreation resource development measures will be identified. Annual average recreation benefits attributable to the provision of new recreation resources will be determined in accordance with accepted guidelines. The need for and provision of project-related recreation measures will be analyzed in light of Corps Resource Management Plans and local and State recreation needs as identified in appropriate State Comprehensive Outdoor Recreation Plans. Project-related recreation features that might be considered include, but are not limited to, picnicking facilities, boat docks, fishing areas, hiking and biking paths, scenic overlook and pedestrian bridges, and other river related accesses. Provisions for use of facilities by the elderly and handicapped will be considered in the design of any recreation features.

Recreation studies will be closely coordinated with environmental and cultural investigations to assure compatibility among proposed design features.

Social

Investigations conducted during the feasibility study will analyze the social effects construction activities have on employment, community services, safety and health, noise and air pollution, and local transportation. Social effects resulting from energy requirements and conservation will also be assessed. In addition, should significant amounts of transmission facilities be required, impacts on property acquisition and relocation, community cohesion, aesthetic quality, and land use will also be assessed.

Institutional studies will investigate the consistency and impact of Corps facilities with existing power generation and distribution systems.

Cultural Resources

Because of the extensive prehistorical and historical use of the Mississippi River valley, actions related to hydropower development, such as powerline construction, stream diversion, channel flow changes, access road construction, powerhouse construction and riprapping, would be preceded by a cultural resource study. Coordination with the National Park Service, the State Historic Preservation Officer, and the State Archeologist will be initiated.

INTRAOFFICE COORDINATION

The requirements of the planning process necessitate an interdisciplinary planning approach to identify and define the planning objectives, develop creative alternative plans, and analyze a broad range of complex issues, including the probable economic, social, and environmental consequences of plan implementation. This is best accomplished by a planning team which employs a diversity of professional skills.

The interdisciplinary team approach works best when all participants have equal opportunity to be involved. This requirement does not mean that all participants will be involved in each activity, task, or stage, only that they will be involved when their skills could have a material effect on study progress and output.

The role of the study manager is pivotal to the successful accomplishment of interdisciplinary planning since the manager is responsible for coordinating and synthesizing the efforts of all involved. A study team concept described above with a study manager coordinating that team will be instituted early in the feasibility study.

WORK SCHEDULE AND STUDY COST ESTIMATE

Milestone schedule

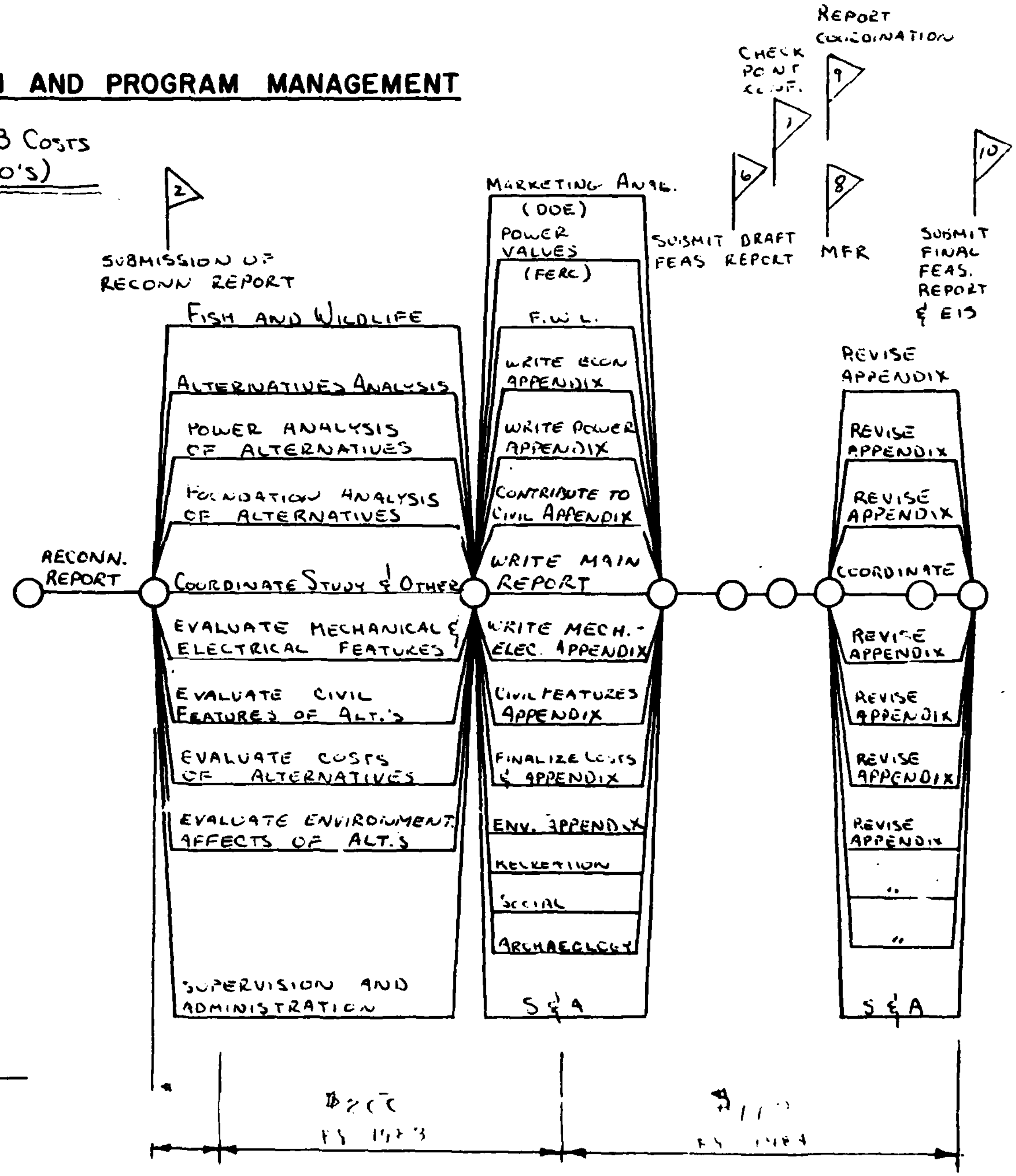
Milestone number	Designation	Completion
6	Submission of draft feasibility report	Apr 1984
7	Stage 3 (Stage 2 for hydropower studies) checkpoint conference	May 1984
8	Completion of action on conference MFR	June 1984
9	Coordination of draft environmental impact statement	June 1984
10	Submission of final feasibility report and revised draft environmental impact statement to Division	Sep 1984

A study schedule is shown on the critical path network which follows. To accomplish the schedule, the Corps needs $200,000 in fiscal year 1983 and $113,000 in fiscal year 1984. The study cost estimate (PB-6), which also follows, shows the breakdown of that funding.

RESOURCE ALLOCATION AND PROGRAM MANAGEMENT

STAGE 3 COSTS
($ 1000's)

STUDIES BY OTHERS	MARKETING ANALYSIS	
	POWER VALUE ANALYSIS	
	FISH AND WILDLIFE STUDIES	6.0
ST. PAUL DISTRICT STUDIES	ECONOMIC AND FINANCIAL	11.0
	HYDROLOGIC POWER	18.0
	FOUNDATIONS	37.0
	PLANNING STUDIES	63.0
	MECHANICAL AND ELECTRICAL	40.0
	CIVIL FEATURES	50.0
	DESIGNS AND COST	30.0
	ENVIRONMENTAL, RECREATION, SOCIAL	35.0
	SUPERVISION AND ADMINISTRATION	50.0
	TOTAL COSTS	$340



Rev 10 Feb 82

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations

CATEGORY: Survey

CLASS: Flood Control

NAME OF STUDY: MISSISSIPPI RIVER, COON .DS DAM
OHIO RIVER
INTERIM REPORT #8 (L&D 2)

SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT FEDERAL COST ESTIMATE — ACCOUNT STAGE 1	STAGE 2	STAGE 3	TOTAL	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED (10 Oct 80)	REMARKS
	a	b	c	d	e	f	g	h
1	.00	Costs thru 30 Sep 78						
2	.01	Public Involvement	1		15	16	16	
3	.02	Institutional Studies	0		1	1	1	
4	.03	Social Studies	0		2	2	2	
5	.04	Cultural Resource Studies	0		5	5	5	
6	.05	Environmental Studies	1		28	29	29	
7	.06	Fish & Wildlife Studies	1		6	7	7	
8	.07	Economic Studies	4		11	15	29	
9	.08	Surveys & Mapping	0		7	7	7	Increase due to investi-
10	.09	Hydraulics & Hydrology	2		18	20	29	gations found to be needed during recon
11	.10	Foundation & Materials	3		30	33	19	study.
12	.11	Design & Cost Estimates	5		80	85	28	Increases due to detailed design required in DPR.
13	.12	Real Estate Studies	0		2	2	2	
14	.13	Study Management	6		18	24	24	

DATE PREPARED: 19 Jun 81
DIVISION: North Central
DISTRICT: Rock Island
REGION: UPPER MISSISSIPPI
BASIN:
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ENG FORM 1 APR 77 2204 EDITION OF 4 JAN 71 IS OBSOLETE.

Figure D-2

RCS: DAF IB-12

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations

CATEGORY: Survey

CLASS: Flood Control

NAME OF STUDY: MISSISSIPPI RIVER, COON R. DS DAM
OHIO RIVER
INTERIM REPORT #8 (L&D 2)

SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT FEDERAL COST ESTIMATE: ACCOUNT STAGE 1	STAGE 2	STAGE 3	TOTAL	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED (10 Oct 80)	REMARKS
	a	b	c	d	e	f	g	h
1	.14	Plan Formulation	0		9	9	9	
2	.15	Report Preparation	0		18	18	18	
3	.20	Other Studies	0		40	40	59	
4		Mechanical and Electrical			(40)	(40)	(59)	
5	.31	Supervision and Administration	2		50	52	41	
6								
7								
8								
9								
10								
11								
12								
13								
14		TOTAL	25		340	365	325	

DATE PREPARED: 19 Jun 81

DIVISION: North Central

DISTRICT: Rock Island

REGION: Upper Mississippi

BASIN:

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ENG FORM 1 APR 77 2204 EDITION OF 4 JAN 71 IS OBSOLETE.

PROCEDURE FOR APPROVAL OF FEASIBILITY REPORT

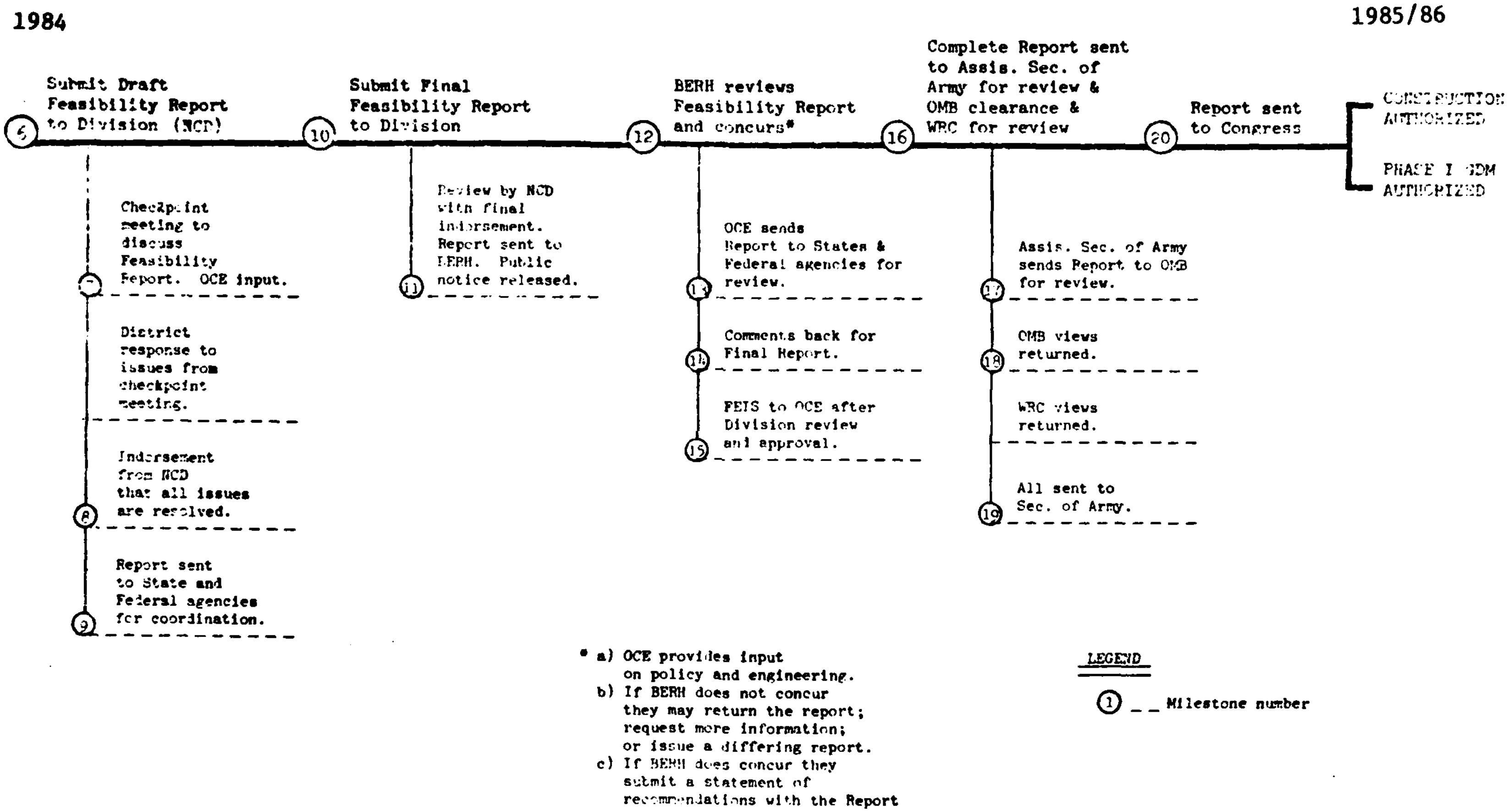

Figure D-3

Rev 10 Feb 82

APPENDIX E

ENVIRONMENTAL APPENDIX

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APPENDIX E

ENVIRONMENTAL

INTRODUCTION

Lock and dam 2 is located on the upper Mississippi River (river mile 815.2) in Hastings, Minnesota. Located in Dakota County, lock and dam 2 is approximately 24 river miles (20 highway miles) southeast of St. Paul, Minnesota.

Lock and dam 2 forms and regulates pool 2 on the Mississippi River which extends 32.5 miles upstream to lock and dam 1 in Minneapolis, Minnesota. Pool 2, as is typical of most pools on the Upper Mississippi River, inundates the floodplain near the downstream end with the navigable channel meandering through the river valley. About 10 miles upstream of lock and dam 2, with the exception of several backwater lakes, pool 2 becomes confined to the old river channel. A major tributary, the Minnesota River, enters pool 2 at river mile 844.

Downstream of lock and dam 2, pool 3 on the Mississippi River extends 18.3 river miles to lock and dam 3 located 5 miles upstream of Red Wing, Minnesota. Pool 3 is slightly more than one-half the length of pool 2; however, pool 3 contains nearly twice the surface area of pool 2 which is indicative of the extensive backwaters of pool 3. The St. Croix River, a major tributary of the Mississippi River, flows into pool 3 at Prescott, Wisconsin (river mile 811.5). The Prairie Island Nuclear Power Plant, a 1,100 megawatt twin reactor, is also located at the downstream end of pool 3.

WATER QUALITY

Water quality in pool 2 has been degraded by discharges of the Metropolitan Wastewater Treatment Plant (river mile 835.2), located 20 miles upstream of lock and dam 2. This treatment plant adds more than half of the biochemical oxygen demand and nutrient loading (nitrogen and phosphorus) of pool 2. Also contributing to this degradation of water quality in pool 2,

are four industrial discharges between lock and dam 2 and the treatment plant.

In the past, the quality of water entering pool 3 during low flows was often deficient in oxygen due to the high oxygen demand of organic matter discharged at the wastewater treatment plant. To alleviate this condition at flows less than 3,000 cfs, water is passed over bulkhead gates and the spillway at lock and dam 2. This modification results in dissolved oxygen values in the tail water that seldom drop below 5 mg/l.

The Minnesota Department of Health has recommended limited human consumption of fish taken from the Mississippi River between Alma, Wisconsin, and Minneapolis on the basis of the bioaccumulation of heavy metals and polychlorinated biphenyls (PCBs) in these fish. This recommendation includes fish taken from pools 2 and 3.

The Minnesota Pollution Control Agency has adopted standards of water quality. Under these standards, waters are arranged into six categories on the basis of use (e.g., domestic water supply, fisheries, recreation, etc.). Each category has different classes based on water quality. A detailed discussion of these water quality standards can be found in the Minnesota Code of Agency Rules, Pollution Control Agency, WPC 15 and WPC 25. The following paragraph lists the categories and classifications of those regions of the Mississippi River pertinent to the study area.

The Mississippi River from St. Anthony Falls to the Iowa border (includes pools 2 and 3) has been placed into two categories. The first category is fisheries and recreation. Under this category, the reach from the outfall of the wastewater treatment plant (river mile 835.2) to river mile 830.3 has been designated as class C. The remaining portion was placed in class B. The second classification is industrial consumption, class B, and includes the whole region from St. Anthony Falls to the Iowa border.

HABITAT

Each pool along the Mississippi River may be divided latitudinally and longitudinally into distinct physical types. Each physical type may be associated with a distinct biological habitat.

Latitudinal divisions include the main channel, main channel border, side channels, and river lakes and ponds. The main channel and main channel border are those regions of the river cross section that carry the primary river current. Side channels are transitions between main channels and river lakes and ponds (backwaters). Backwater areas have low flow, shallow depth, silt bottoms, and contain exceptionally diverse vegetation. These areas provide a habitat for a wide variety of fish and wildlife.

Longitudinal divisions include the tail waters, midpool, and impounded area. The tail-water area immediately below the dams includes the main channel and main channel border areas which are affected by the turbulence of water passing over the dam and through locks. The tail waters area most resembles the original river channel before the locks and dams were constructed. High oxygenation and fast water make these areas particularly valuable as fishery habitat, particularly for spawning. In the middle of the pools, water covers lands that were once islands and hay meadows forming large areas of marshes and shallow water. Immediately above each dam the impoundment areas are characteristically open and deep.

FLORA AND FAUNA

PLANTS

Because the river is impounded, areas outside the main channel and border areas have little or no current. Phytoplankton, ordinarily uncharacteristic of riverine conditions, develops in blooms. Submerged and emergent aquatic vegetation grows in areas of low current. In the backwaters, the diversity of the vegetation is exceptional.

FISH

Sixty-one species of fish have been collected from pools 2 and 3 of the Mississippi River. Of these, 25 are common and 5 are abundant. These species include both commercial and game species. No commercial fishing takes place in pool 2 but there is commercial fishing in pool 3. Game species include walleye, sauger, northern pike, largemouth bass, bluegill, and crappie, both black and white.

SHELLFISH

Fifty-one species of unionid clams are known in the Upper Mississippi River. Sphaerid or fingernail clams have many fewer species but may occur in high densities. Sphaerids occur mainly in the backwaters and provide food for migratory waterfowl and several species of fish. Unionids occupy stable substrates over a range of habitats. Clams are harvested commercially to provide seed material for the cultured pearl industry. This activity takes place in pools 9 and 10. Two species have been placed on the Federal Endangered Species list. An introduced exotic species, the Asiatic clam Corbiciela leana has been found in the Mississippi and St. Croix Rivers. This species has caused considerable problems to the power generation industry by growing in such large numbers that water intakes and condenser cooling pipes have been blocked by the clams.

TERRESTRIAL HABITAT

The vegetation of the bottomland hardwood forest includes an overstory of elm, maple, willow, ash, and cottonwood and an understory of nettle, poison ivy, wild grape, woodbine, dogwood, chokecherry, and tree seedlings. When flooded, the forest provides spawning habitat for fish such as northern pike. At all times it provides habitat for tree nesting ducks, raccoon, white-tailed deer, cottontail rabbit, fox, songbirds, reptiles, and amphibians. The bottomland hardwood forest is generally found in the upstream and midpool areas and is representative of the preimpoundment river.

Low-lying areas which are not well drained are dominated by grasses, rushes, and sedges. These areas provide spawning habitat for northern pike and carp as well as nesting and feeding habitat for waterfowl. Raptorial birds feed in these areas and they are used by various birds (e.g., pheasant, wild turkey) and small mammals (e.g., mice and squirrels).

SOCIAL SETTING

Lock and dam 2 is at river mile 815.2 in Hastings, Minnesota. The city of Hastings is located in Dakota County and within the Minneapolis-St. Paul Standard Metropolitan Statistical Area (SMSA). The County and City Data Book of 1977 reports that the population of Hastings was 15,457 in 1975 (a 26.7 percent increase from 1970). The estimated per capita income in 1974 for Hastings was $4,428 compared to $4,675 for the State of Minnesota (U.S. Bureau of the Census, 1977). According to 1970 Census data, major industrial employers in Hastings were primarily composed of manufacturing (36.8 percent), services (21.8 percent), and wholesale and retail trade (17.1 percent). Construction accounted for 7.2 percent of all industrial employment.

RECREATIONAL SETTING

Pool 2 is not a recreation magnet due to poor water quality and heavy commercial traffic. In terms of recreational lockages in 1980, lock and dam 2 ranked eighth in the 13 St. Paul District locks. Many of the recreational boaters locking through lock and dam 1 are going downstream, with pools 3 and 4 as their recreation destination.

Sport fishing in pool 2 is low. Pollution from the Twin Cities limits both quantity and quality of fish caught. To avoid the more polluted middle area of the pool below the sewage disposal plant at Pig's Eye Island, most fishing occurs near the locks. Hunting is limited because of local ordinances in the urban areas. Some trapping occurs around the Grey Cloud Island area.

Because of poor water quality conditions, existing demand for water-oriented recreational use (swimming, boating, fishing, etc.) is low. Industrial and commercial development limits demand for camping and picnicking.

Sightseeing is the most predominant recreational activity in pool 2 and is projected to continue to be so. Overall activity occasions in pool 2 are expected to increase from an estimated 219,600 in 1980 to 335,900 in 2025. If the water quality is improved in pool 2, the recreation demand is expected to be much greater than presently projected for boating and other water-related recreational activities.

Pool 3, including the lower 33 miles of the St. Croix River, is heavily used by recreationists. Although pool 3, like pool 2, is relatively close to the metropolitan area, it likewise has limited access for recreationists.

Lake Rebecca Municipal Park, adjacent to lock and dam 2 in Hastings, is the closest park to the study area. This park is presently being developed by the Corps of Engineers. Other recreation sites in the area include several private marinas and harbors which are located near Prescott and Hastings. Spring Lake County Park is the closest park on pool 2 to lock and dam 2.

Sport fishing in the Mississippi segment of pool 3 is not as popular as it is in downstream pools because of water pollution in the area. Hunting, however, is popular in this part of the pool. Game and waterfowl are both hunted. Bag checks by the Minnesota Department of Natural Resources reveal waterfowl harvests comparable with the State average.

The confluence of the St. Croix River and the Mississippi River is about 4 river miles downstream from lock and dam 2. The St. Croix River is the recreation destination of many boaters locking through lock and dam 2.

Overall activity occasions in pool 3 (including both segments) are expected to increase from an estimated 1,005,800 in 1980 to 1,651,300 in 2025. Estimated resource deficiencies in the pool have been indicated for hunting areas and boat access launching lanes and adjacent parking.

CULTURAL RESOURCES SETTING

The Mississippi River valley has been intensively occupied during prehistoric and historic times. Indian villages and campsites were located throughout the valley and burial mounds were built along the bluff tops. The valley also served early as a trade route for European explorers and fur traders. As a result of European expansion westward, early river towns sprang up to handle the increase in commerce.

In accordance with Section 106 of the National Historic Preservation Act, the National Register of Historic Places has been consulted. As of 1 March 1981, no sites listed on the National Register will be impacted by the proposed construction at lock and dam 2, although a number of properties are located in nearby Hastings.

APPENDIX F

EXISTING 40-KW HYDROPOWER PLANT

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APPENDIX F

EXISTING 40-KW HYDROPOWER PLANT

EXISTING CONDITIONS

A small 40-kW hydropower plant was installed at the riverward lock as part of the original construction of lock and dam 2. Located on the river wall of the lock, the energy produced by the hydropower plant was used to operate the lock machinery. Though not presently in operation, the components of the plant are still in place. A brief description of these components follows.

A square tunnel (7 feet x 7 feet) passes longitudinally through the river wall and serves as a channel to divert river flow through a vertical francis turbine. The alignment of this tunnel as well as the location of the powerhouse is shown on plate 1 (at the end of the main report). The turbine is rated at 85 hp at 10 feet of head. A vertical shaft and bevel gear transmit the torque from the turbine to a 40-kW d.c. generator. It is not known how much of the original electrical features inside the powerhouse are intact and could be used for future hydropower production.

REHABILITATION

Several considerations must be addressed if the existing hydropower plant is to be rehabilitated. These considerations include:

1. The existing d.c. generator will be replaced by an a.c. generator.

2. During the 1965 flood, the powerhouse was under approximately 5 feet of water. Any nonimmersible equipment should be easily removable, elevated, or waterproofed.

3. No wiring, poles, or other hook-ups to the current system exist. Provisions for these features could easily be made in later design of new hydropower development at lock and dam 2.

4. Placement of new hydropower turbines in the spillway dam as proposed in the alternatives examined in the reconnaissance report might require blocking the intake tunnel of the existing hydroplant and thereby prohibit the rehabilitiation of the plant. As indicated in the reconnaissance report, new hydropower development would most likely occur on a 4- or 5-MW scale (alternatives 1 and 2 were found to be economically feasible while larger capacities were found infeasible). At this scale, turbines could be exclusively located in the riverward lock instead of using the spillway dam location. Using the cost tables of appendix A to compare the 4-MW alternative with the 8-MW alternative and similarly the 5 MW with the 10 MW, in both cases one notes a slightly less than doubling of the cost for twice the capacity. In both cases, since the difference between alternatives is the addition of the same number of turbines located in the riverward lock, it appears that no significant change in cost would occur if the 4- or 5-MW alternatives were relocated in the riverward lock, thus enabling the rehabilitation of existing capacities.

Allis Chalmers was contacted in regard to the rehabilitation of the existing hydropower equipment at lock and dam 2. Their proposal is included at the end of this appendix. Allis Chalmers quoted a price of $46,700 for the rehabilitation of the existing francis turbine and drive system as well as the purchase of a 40-kW induction generator, motor-operated gate positioner, speed increaser, motor starter, and necessary anchor bolts.

Currently, other firms are being contacted in regard to the rehabilitation of the existing hydroplant at lock and dam 2. These firms include:

James Leffel Company, Springfield, Ohio - the holder of patent on the original turbine at lock and dam 2. Although the turbine is no longer manufactured by Leffel, the company has rehabilitated several similar turbines. The cost of inspection and feasibility report is $500 and does not include shipping the turbine to the Lefferl plant (verbal quote).

Perkiomen Water Wheel Company, Collegeville, Pennsylvania - This company was contacted by telephone and will submit a proposal after review of drawings, curves, and other information has been completed. The Perkiomen Company would replace all equipment including the existing turbine at a total cost guaranteed not to exceed $600/kW.

ECONOMICS

Since the capacity of the rehabilitated plant will be very small compared to other plants, two assumptions are made:

1. No other alternative energy source would be constructed to specifically replace this plant. Therefore, capacity benefits are nonexistent.

2. River flow would be sufficient to permit the continual operation of the turbine. Down time would almost exclusively be due to routine maintenance. Therefore a plant factor of 0.99 is assumed.

These assumptions were used in preparing the economic analysis that appears in table F-1. A 40-kW capacity was used. However, it should be noted that the 85-hp turbine could drive a generator as large as 60 kW. The Allis-Chalmers proposal was used to estimate the rehabilitation cost of $50,000. Annual charges were based on an interest rate of 7 3/8 percent and an amortization period of 100 years. Since the rehabilitated hydroplant would most likely be used to displace some of the energy purchased from NSP (Northern States Power), the rates that NSP would charge a customer for the energy produced at the hydroplant were applied to estimate the benefits.

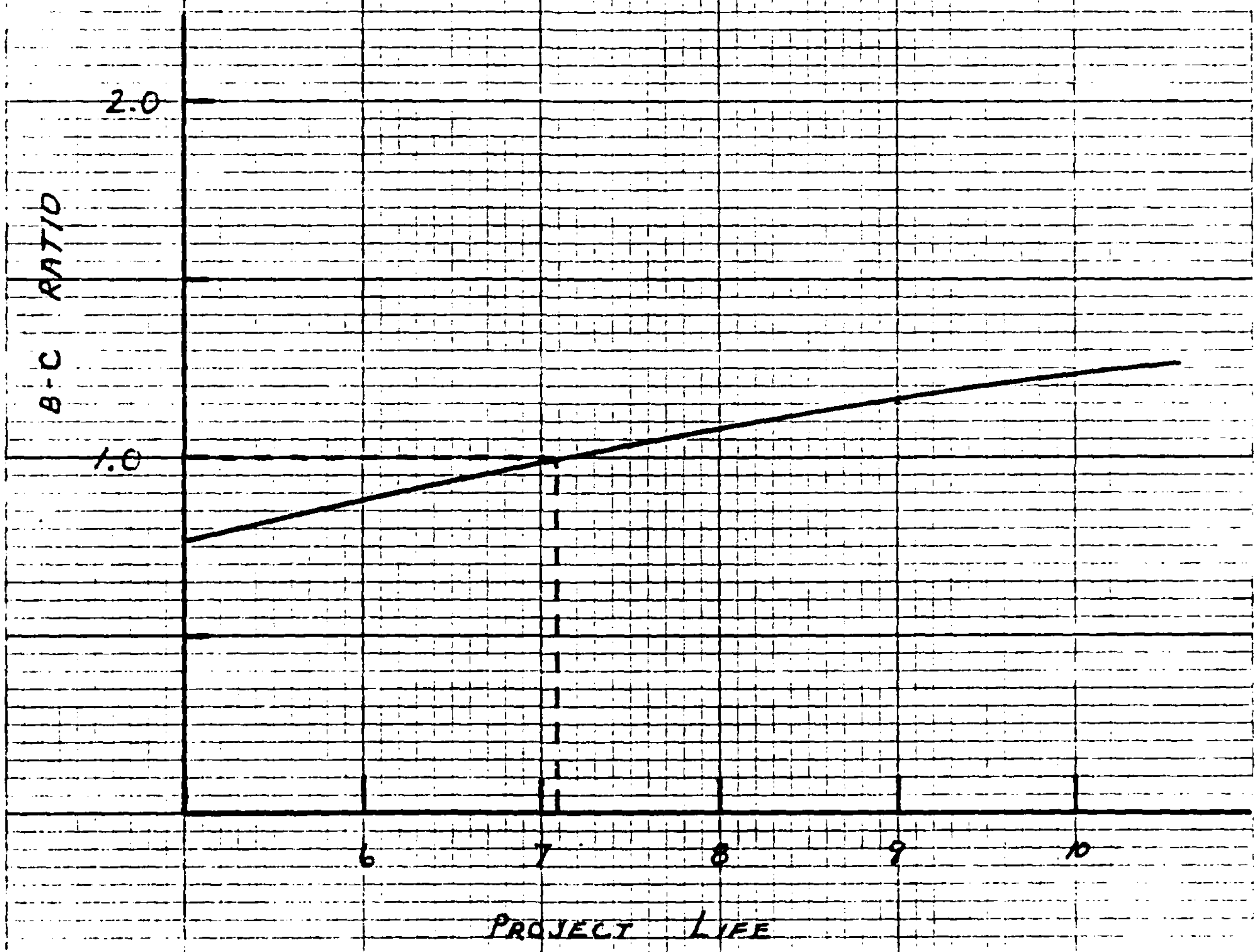
Table F-1 - Estimated annual costs and benefits

Item		Amount
Rehabilitation first costs		$50,000
Average annual cost		3,690
Operation and maintenance		1,000
Total average annual cost		4,690
Average annual energy benefit(1) (347 MWh/yr)($22.8/MWh)	=	7,900
Average annual demand benefits(2)		
($4.30/kW)(40 kW)(9 months)	=	1,548
($5.85/kW)(40 kW)(3 months)	=	702
Total average annual benefits		10,150
Benefit-cost ratio		2.17

(1) Based on NSP energy charge. Current as of August 1981.
(2) Based on NSP demand charge. Current as of August 1981.

Figure F-1 was constructed to determine the length of time that would be required for the benefits received from the power plant to pay for the plant rehabilitation and operation costs. The graph in figure F-1 represents the benefit-cost ratio as a function of project life. The interest rate was kept at 7 3/8 percent. From the graph, a 1.0-benefit-cost ratio is reached at a 7.1-year project life. Therefore, it appears that the 40-kW rehabilitation would pay for itself in about 7 years.

FIGURE F-1. B-C RATIO AS A FUNCTION OF PROJECT LIFE



FUTURE ACTION

The St. Paul District Energy Committee has been studying the future of the existing hydroplant at lock and dam 2. The committee has recommended that the rehabilitation take place. The rehabilitation would be done through operation and maintenance funding as the rehabilitation project is simply the return to operation of an existing facility. No firm time schedule for the rehabilitation has yet been established.

No conflict is seen between larger scale hydropower development and rehabilitation of the existing unit for the following reasons:

a. Rehabilitation could take place relatively rapidly (by 1983 or 1984). Even if new hydro development precludes use of the rehabilitated unit, the rehabilitation would pay for itself by 1990 when larger units are assumed to be on line.

b. Advance planning studies on development of new hydropower at lock and dam 2 will consider the plan for rehabilitation of the existing unit. Should the rehabilitation be found workable and the unit is put back into operation, the studies will evaluate measures for compatible operation of both the new development and rehabilitated units.

FIELD SERVICE OPERATION

Field Service Contract

PROPOSAL NO. 6-36769-J
DATE May 1, 1981
PAGE 1

To Dept. of the Army, St. Paul District, Corps of Engineers
(Hereinafter called the Purchaser)

Address 1135 U.S. Post Office & Custom House, St. Paul, Minnesota 55101

Attention Ronald E. Scott
Acting Safety Manager

Purchaser's Reference

Job Site Hastings Lock and Dam

To Begin

Equipment Description Inspection and Evaluation of Trumpe Hydraulic Turbine and Accessories

ALLIS-CHALMERS CORPORATION (hereinafter called the Company) proposes to provide Purchaser those services in connection with the equipment described above as are specified in The Description of Work subject to the *General Provisions for Field Service*, Form 5990, attached and subject to the following price schedule.

Representatives Straight Time Rate $50.00/hour

Plus Actual Expenses

M & H EQUIPMENT COMPANY
3940 West 49½ Street
Minneapolis, MN 55424
612 - 927-6518

This Proposal will remain in effect for 30 days after the date shown above. Acceptance should be evidenced by return within the foregoing time limit of one copy of this Proposal signed by the Purchaser's authorized representative in the place set forth below, or by a letter or a Purchase Order confirming the date such service is to be performed. It will become a contract at that time. Except for specification of the time of service, any terms and conditions of such Purchase Order in addition to or at variance with this Proposal shall be of no effect unless separately agreed to in writing by the Company.

ACCEPTED:	ALLIS-CHALMERS CORPORATION
(Name of Purchaser)	By Robert C. Johnson Jr.
By	Title Robert C. Johnson, Jr. Manager, Field Service
Title	Date May 1, 1981
Date	

8872-3 PRINTED IN U.S.A.

ALLIS-CHALMERS

Contract

Contract No.
Proposal No. 6-36769-J
Date May 7, 1981

TO DEPARTMENT OF THE ARMY, ST. PAUL DISTRICT, CORPS OF ENGINEERS (Purchaser)

ADDRESS 1135 U.S. Post Office & Custom House, St. Paul, MN 55101

ATTENTION Mr. Ronald E. Scott, Acting Safety Manager

Allis-Chalmers Corporation (Company) agrees to sell to Purchaser and Purchaser agrees to purchase from Company the product(s) described below.

PRODUCT(S):

HASTINGS LOCK AND DAM POWER PLANT

In order to determine firm costs necessary to rehabilitate the existing vertical Francis turbine at Hastings Lock and Dam Power Plant, Allis-Chalmers proposes the equipment be disassembled and shipped to the Hydro-Turbine Division Plant in York, PA.

Previous experience has indicated that it is otherwise impractical to determine an accurate fixed or firm price for rehabilitation of existing hydro units. Therefore, as an industry practice, we recommend that the equipment be completely disassembled and evaluated on site or alternatively at our plant at York the unit can be thoroughly cleaned and an evaluation performed by our engineering staff to determine the scope of work required to rehabilitate the unit in order to restore it to an operable condition. Upon completion of the inspection and evaluation, a proposal with firm price quotations would be submitted to perform any necessary rehabilitation work. This procedure results in a minimum initial investment to determine reliable cost information for restoring hydro units to operating service.

Specifically for Hastings Lock and Dam, Allis-Chalmers proposes that the existing vertical Francis turbine, vertical drive shaft, bevel gear drive, and automatic turbine control be removed from the Lock and Dam, and that the entire turbine wheelcase be returned to the Hydro-Turbine Division at York, PA as a unit assembly, along with the above referenced parts.

The following information describes the proposed work at the Allis-Chalmers York Plant:

1) Receive, disassemble and mark all parts, check part dimensions for clearance of mating parts.

2) Clean (metal blast or sand blast at A-C option) all usable parts. Machined surfaces will be protected prior to cleaning.

3) Perform a visual inspection of all parts. In addition, nondestructively examine critical components as required.

4) Install vertical drive shaft in lathe, indicate, and determine straightness.

5) Submit an engineering report covering the shop inspection, outline specific requirements for repair and/or rehabilitation of the existing equipment.

6) Submit a firm price quotation for repairing and/or rehabilitating the equipment as determined by the shop inspection and evaluation.

7) This proposal does not include the removal of equipment from the Hastings Lock and Dam Power Plant, or loading the equipment for transport (truck or freight car), or transportation costs between the Hastings Lock and Dam Power Plant and the Allis-Chalmers York Plant, or transportation of the equipment back to the project site.

TOTAL FIRM PRICE FOR WORK DEFINED ABOVE:

SEVEN THOUSAND DOLLARS $7,000.00

Estimated time to perform cleaning, inspection, and evaluation of Francis turbine, vertical drive shaft, bevel gear drive, and automatic turbine control—fourteen (14) weeks.

Should the above evaluation confirm the economical use of your existing turbine Allis-Chalmers recommends the purchase of:

1) Motor operated gate positioner (using existing gate shaft) with necessary limit switches and controls.

2) Speed increaser (327 to 920 RPM) with couplings for high speed and low speed drive shafts.

3) 40 kW induction generator (480 volts) with terminal box and heaters.

4) Motor starter (Size 4) with control and indication panel for 40 kW generator.

5) Necessary anchor bolts.

NOTE: Interconnecting wiring, busbar or cables are not included between generator and control cubicle or remote location.

TOTAL FIRM PRICE FOR ITEMS 1-5 ABOVE:

THIRTY-NINE THOUSAND SEVEN HUNDRED DOLLARS . . $39,700.00

Estimated shipment time 6 months from receipt of contract and approved drawings.

If desired:

Equipment removal and installation supervision will be provided under the terms and conditions of Field Service Contract 5-36769-J dated May 1, 1981.

ALLIS-CHALMERS

Contract No. ____________
Proposal No. 6-36769-J
Date May 7, 1981

Contract

PRICE(S):

Turbine and accessory evaluation at York, PA	$ 7,000.00
40 kW Induction generator with accessories	39,700.00
Equipment removal and installation per Field Service Contract dated May 1, 1981	
TOTAL PRICE:	$ 46,700.00

TAXES: None Included

Any applicable duties or sales, use, excise, value-added, or similar taxes will be added to the price and invoiced separately *(unless acceptable exemption certificate is furnished).*

PRICE POLICY CLAUSE: Firm

TERMS OF PAYMENT: Net 30 days from Date of Shipment or offer to ship

Unless otherwise stated, all payments shall be in United States dollars, and a pro rata payment shall become due as each shipment is made. If shipment is delayed by Purchaser, date of notice of readiness for shipment shall be deemed to be date of shipment for payment purposes.

On late payments, the contract price shall, without prejudice to Company's right to immediate payment, be increased by 1½% per month on the unpaid balance, but not to exceed the maximum permitted by law.

If at any time in Company's judgment Purchaser may be or may become unable or unwilling to meet the terms specified, Company may require satisfactory assurances or full or partial payment as a condition to commencing or continuing manufacture or making shipment, and may, if shipment has been made, recover the product(s) from the carrier, pending receipt of such assurances.

SHIPPING DATE: 6 months from receipt of contract and approved drawings

DELIVERY TERMS: F.O.B. Factory

OTHER TERMS:

This offer will remain in effect for 30 days, unless changed in the interim upon written notice from Company.

Documents and related correspondence shall be sent to the Allis-Chalmers office at: P. O. Box 712, York, PA 17405, Attn: H. A. Mayo, Jr., P.E.

Field services furnished by Company employees, whenever specified, are governed by the provisions of Company form 5990.

This document and any other documents specifically referred to as being a part hereof, constitute the entire contract on the subject matter, and it shall not be modified except in writing signed by both parties.

THIS CONTRACT INCLUDES THE GENERAL PROVISIONS ON THE REVERSE SIDE

DATE
ILMED

– 8